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EDITORIAL

Board of Trade Statistics

IN addition to the statistics giving the industrial production of this country for the year 1932 and a comparison of the figures with those of the years 1930 and 1931, the *Board of Trade Journal* for February 23 contains a long special article on the Balance of Trade for the years 1930, 1931, and 1932. The balance is obtained by adding the net Government payments made overseas to the excess of imports of merchandise and silver, and deducting from this total the figures, formerly called invisible exports, represented by the net income from shipping, net income from overseas investments, net receipts of sundry interest and commissions, and net receipts from other sources. In the year 1931 the excess of imports over exports was 408 million pounds sterling of which 304 million £ came to us as income from shipping, overseas investments, and the other items mentioned above, leaving 104 million £ as a debt to be paid for at some time or other. For the year 1932 the adverse balance has been reduced from 104 million £ to about 59 million £, still a rather large figure which should decline this year. From the figures relating to unemployment, industrial production, and imports and exports it appears that the rapid decline in the industry of this country that has been so manifest during recent years has now come to an end; the figures are now practically stationary and there is every reason to think that they will now begin to show an improvement. The prodnction of the chemical and allied trades in 1932 shows some improvement over that in 1931 and so does the textile trade: the production of gas and electricity has also increased during last year. This is some evidence though slight of an improving tendency.

Round the Fair

The Chemical Section of the British Industries Fair is definitely more attractive this year: it is in a new position and there is a larger proportion of open stands, so that it is possible to gain a more collective view of the treasures exhibited. There are chemicals everywhere, in bottles and in jars, in drums or in kegs, or heaped up on open trays; chemicals liquid and solid, amorphous or crystalline, plain or coloured, chemicals which attract by their smell or amaze the unwary by the length of their names. Some are useful in medicine, some in foodstuffs, others in a thousand and one different industries. Each one of them represents an achievement first in the laboratory and later in the factory. Our own stand is in a prominent position: for the thoughtful it symbolizes how much the written word, the recorded paper, the careful abstract has contributed to the advance: how the discussions, the stimulus given by the meetings have sent those attending them back to their laboratories and factories inspired with new ideals and the zeal to achieve them. We are indeed appropriately housed in the centre of such an exhibition. Of the individual exhibits it is difficult to write: all deserve mention, for even where there are no novelties the year has been a period of consolidation, of effort to make purer products at lower costs, of a search for new applications. The I.C.I. show the oldest of chemicals, chlorine and sodium carbonate, in the newest of dressings, with some excellent sales literature: it is plain that the fertility of ideas in this direction has far from been exhausted. In particular we refer to fused sodium carbonate blocks for use in the iron foundry, where they help to effect considerable savings: we have previously discussed this subject. Further, there is the monohydrate of sodium carbonate, now being manufactured by a new process which yields it in the form of crystal agglomerates of attractive appearance. Among other uses for it we have discovered one which exemplifies the degree of thought which is nowadays required to capture a market. It is used for the preparation of bath salts for export to foreign markets where the climate is hot: *the washing soda crystals, i.e., the decahydrate*, which are the basis of our home bath salts, melt at 90° F. and are unsuitable for export. Hydroquinone has pride of place as the latest achievement in establishing the large scale manufacture of a fine chemical in this country, but we confess to being more interested in the progress of the synthetic resins and their products. The vinyl acetate polymerization products in particular open up a new field in which we shall expect to see much progress in the future. Solvents are perhaps not quite so much to the fore this year, though we note the growing importance of ethyl lactate in this connexion. The presence in the Chemical Section of the two great gas companies serves to remind us that the bulk of the organic products shown are based on coal tar as raw material, though the fact that the reign of King Coal is menaced is exemplified by adjacent stands, where the products were in one example derived from carbides and the other from alcohols obtained by the fermentation of molasses. It is true carbide is derived from coke, but the chief factor in the transformation is electric power. The chemical industry continues to expand both in its products and their utilization; the Fair is becoming an excellent barometer of this expansion.

THE QUANTITATIVE ANALYSIS OF CALCITE-ARAGONITE MIXTURES BY X-RAYS

By E. G. COX and T. H. GOODWIN
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Although the method of analysis described here is an application of *X*-ray crystallography which would naturally suggest itself in the case of calcite and aragonite, it is one which, in view of its possible use in a number of problems of scientific and industrial interest, is not sufficiently well known, particularly as it may be applied where chemical methods are tedious, uncertain, or impossible.

In the present case, it was desired to obtain the percentages of calcite and aragonite present in samples of precipitated chalk, in order to assist in maintaining a uniform product. (Since the hardness of the two forms of calcium carbonate is appreciably different, this uniformity is very necessary in a commodity which is used so extensively in the manufacture of dentifrices and for similar purposes.) Chemical methods were naturally not available, and the grain size of the chalk was too small to permit the use of petrographic methods,

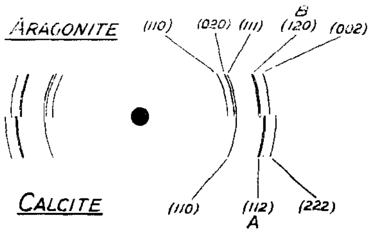

FIG. 1

Analysis of calcite–aragonite mixtures

but it was found that the analyses could be made quite simply by means of *X*-ray powder photographs.

It is well known that calcite crystallizes in the rhombohedral system and aragonite in the orthorhombic, there being pronounced similarity between the two structures, which however are sufficiently different to give rise to quite distinct *X*-ray photographs. Fig. 1 is a diagrammatic representation of the first few lines in the powder photographs of the two, the indices of the planes giving rise to the various lines being indicated. The two lines marked A and B are considerably more intense than the others. Powder photographs of mixtures of the two substances show both sets of lines, their relative intensities depending on the proportions of each present. (The presence of any third crystalline substance is, of course, indicated at the same time by the presence of additional lines.) An analysis can therefore be carried out by comparing the relative intensities of a calcite and an aragonite line in a photograph of the sample, with the relative intensities of the same lines in a photograph of a suitable standard mixture. The two lines A and B are suitable in most cases, since they are fairly strong, so that long exposures are not necessar[y] and are close together.

A small quantity (5 mg. or less) of the sample to b[e] analysed is prepared for the *X*-ray examination b[y] packing it into a tube of Lindemann glass of abou[t] 0·5 mm. diameter, or by pasting it uniformly, b[y] means of a small amount of suitable gum, on to a fin[e] glass hair. The former method is usually to be preferre[d] since on the whole it enables uniform preparations to b[e] obtained more easily; the Lindemann (lithium boro-silicate) glass is used on account of its low coefficien[t] of absorption for *X*-rays. The preparation is mounte[d] on the axis of a small Debye-Scherrer camera and th[e] photographs are taken by means of suitable mono-chromatic radiation (*e.g.*, copper K_{α}). A trial photo-graph is taken, and from it a rough estimate of th[e] percentage composition is made; a repeat exposure [is] then made with a screen so placed inside the camer[a] that only the upper half of the film is exposed. [A] preparation is now made of a standard mixture [of] about the same composition as that estimated fro[m] the trial photograph, and photographed, by means [of] a complementary screen, on the lower half of the sam[e] film. Thus two photographs, one of the sample an[d] the other of a suitable standard, are obtained in regist[er] on the same film, and by eye estimation of the intensiti[es] of the lines A and B on each half it is possible to obtai[n] the percentage composition of the sample. If th[e] sample contains only a small amount of one componen[t] it is more convenient to use other lines for preliminar[y] comparison: *e.g.*, in the case of a mixture containin[g] a few per cent. of aragonite, the aragonite line *B* (12[0]) could be compared with the calcite line (110), whic[h] would have a more nearly comparable intensity—abo[ut] one-thirtieth of the A (112) intensity. The (020) an[d] (111) aragonite lines in such a case would have negligib[le] intensities and so would not cause any confusion b[y] overlapping the calcite (110); in any case allowan[ce] is made for this afterwards by the use of the compariso[n] standard. The accuracy varies from about $\pm 2\%$ i[n] a 1 : 1 mixture to $\pm \frac{1}{2}\%$ or less in a 20 : 1 mixtur[e]; *e.g.*, in two actual samples the amounts of aragoni[te] present were determined as $60 \pm 2\%$ and $3 \pm \frac{1}{2}\%$.

The measurements described here were made wit[h] general purpose apparatus not specially designed f[or] the work; for large numbers of analyses refinemen[ts] could be introduced. Even in the present case, how-ever, the method compares favourably with othe[rs] with regard to the time involved, since although eac[h] photograph may take an hour or more, the actual tim[e] expended by the worker consists only of a few minut[es] each for the three operations of preparing the specime[n], developing the photographs, and making the estimat[e] of the intensities of the lines. A very small amoun[t] of the sample is used, and even this can be recovered.

In analyses of a more general kind it would be nece[s]sary to guard against errors due to variable grain siz[e] and other factors; greater accuracy could be obtaine[d] by using a photometric method for the intensit[y] measurements. For some purposes it would be advan[t]ageous to replace the Debye-Scherrer method by tha[t] of Seemann and Bohlin; cameras are available whic[h] can be used for both.

CHEMISTRY AND NUTRITION*

By W. RAMSAY SIBBALD, A.M.I.Chem.E.

It would seem to be an obvious task for the chemist to describe in detail the chemical processes which govern the transformations of food to suit the needs of the animal, including the human body. The hypothesis that the nitrogenous, energy producing, and mineral constituents of the diet should by a series of fairly simple reactions supply the needs of the frame and tissues and the energy requirements of the body, sounds quite a good one if we leave out of our investigation (on account of the small quantities involved) the constitution and the production of the more complex enzymes and hormones which play such an important part in the processes of life.

The result of an investigation based on such an hypothesis ought to be the determination (within limits) of an *ideal scheme of nutrition*, perfectly suited to the requirements of, for example, the normal human being. When however, we turn to the physiologist for some idea of the requirements of such an individual we find that a basis is by no means easy to find. Recently, wishing to read something on the question of protein supply, I read two fairly recent essays each dealing exclusively and exhaustively with this subject.[1, 2]. Hindhede,[1] by long term experiments on himself, his family, and his friends (he does not mention his enemies), satisfied himself that healthy living could be maintained on a protein intake corresponding to 5 grams of nitrogen daily, about one-third of the accepted standard. The diet consisted of potatoes and butter and bread. The experiment has been repeated by others, and the description of both the visible effects and the investigation of the nutritional balance make very convincing reading. When we turn to McCay[2] and other advocates of the higher standards, we find the facts and the arguments of the other school swept ruthlessly aside. Granted that over a fairly long period such as six months (but which is, they point out, less than 1% of the span of ordinary human life) a healthy man remains healthy and feels well on such a low protein intake, they still assert that little or nothing is proved. McCay adduces the finer physique and the higher mental level of Asiatic native races corresponding to a higher rate of protein metabolism, in contrast with the poorer types in similar climates on low protein diets. He casts doubts on the effect of a really prolonged low level of protein nutrition, and insists with a fair show of logic that the experience of nations over generations should count for far more than even long date experiments on fairly large groups of individuals. Regarded simply as a chemical phenomenon, the greater rapidity with which the products of protein digestion can be assimilated, as compared with the derivatives of carbohydrate foods, forms quite good evidence upon which to argue that the intellectual and even moral, as well as the physical, progress of the human race is connected with its carnivorous habits.

It is clear then that with so much difference of opinion among the physiologists, the time is not ripe for the chemist to devise the ideal diet either in tabloid or any other form. And yet the solution of the problem of the ideal diet may in the end come from the chemist rather than the physiologist and it is at least certain that the chances the latter has of solving it will depend on the extent to which he enlists the aid of the chemist.

Before we deal with the raw material and the products of metabolism in detail it will perhaps be as well to consider, if only in a sketchy manner, the machinery which deals with these. The useful products of digestion must pass through membranes, *i.e.*, must be dialysed. The process of digestion must therefore ultimately reduce the food material to the crystalloid state, and the process is generally one of molecular degradation. At each step in the progress of the food through the alimentary canal it meets gland secretions containing enzymes (and their co-enzymes) capable of carrying out the catalysis of the organic compounds of the raw material at high speed. For example, it has been shown[3] that a preparation of lactase could hydrolyze a 5% lactose solution at 35° C. to the extent of 25% in an hour; with 2N hydrochloric acid solution at the same temperature the hydrolysis only reaches this stage at the end of five weeks.

The only severe mechanical treatment which food receives from the human repository is mastication, a process which is often less thorough than it might with advantage be. During this process the mass is more or less impregnated with amylase and co-enzymes such as phosphate and chloride ions. A gluco-protein, mucin, is also contributed which helps to blend the mass into a doughy consistency so that it can be swallowed. There are also diffusion products from the blood serum which are only incidental. For example, in the true carnivora the small quantity of amylase found in the saliva is considered to be one of these incidental substances carried from the intestinal regional by the blood stream.

The amylase acts upon the starches in a way very similar to the action of mineral acids. Erythrodextrin, *achroodextrin, and finally maltose result, the last* representing the extreme limit of amylase reaction. The essential co-enzyme is the chlorine ion, and the optimum hydrogen ion concentration is in the region of p_H 6·7—a slight degree of acidity which is maintained with the aid of the carbon dioxide of the exhaled breath. The optimum temperature is about 40—50° C. Amylase is destroyed by prolonged exposure to a temperature of 70° or a p_H somewhat below 4 or over 9.

In the next step in the digestion (which takes place in the stomach) the food is exposed to the action of acid media. The mechanical movement of the stomach being very gentle, and the food being in a viscous state, the penetration by acid is slow and the amylase reaction continues for a considerable time, normally 15 or 20 minutes, after the food has passed into the stomach.

The gastric secretion has an acidity corresponding to 0·4% of hydrochloric acid, but it is fairly certain that the free total acid never reaches anything like this concentration owing to the basic nature of the proteins. Doubt has also been cast upon the possibility of any of the tissues tolerating such a concentration of free acid, and various hypotheses have been advanced

* Read before the Liverpool Section of the Society of Chemical Industry on October 28, 1932.

suggesting association of the hydrochloric acid up to the moment of contact with the food. The final result is a mixture of hydrochloric acid in combination with proteins (and products of these) together with free hydrochloric acid to the extent of 0·2% of the liquid.

In addition to hydrochloric acid the gastric secretion contains pepsin, rennin, and small amounts of a lipase. There is little movement in the stomach, a gentle and slow peristalsis simply moving the food mass slowly from the cardiac end of the stomach to the pylorus. The progress is accompanied by gradual liquefaction. The liquid passes through the opened pylorus, simply because of its fluid condition. The acidity, however, so acts upon the nerves in the duodenum that the pylorus resumes its normal closed position. To this portion of the stomach contents, held in the duodenum, are now added intestinal secretions from the glands in the walls of this organ, and a supply of bile. In the intestinal juices occurs secretin, a hormone which has the effect of stimulating an outflow of pancreatic juice. All these additions are alkaline and the fluid nutritive mass is soon neutralized. With this condition on the duodenal side, and the pressure of fluid on the stomach side, the pylorus opens and a fresh discharge of the stomach contents into the duodenum takes place. The alternation of opening and closing of the pylorus is repeated until the fluid contents and finally undigested solid matters have all left the stomach.

The effect of the gastric acids and enzymes has been the hydrolysis of the sugars and proteins. A little fatty acid may be present (from the action of lipase), but the main products of digestion are proteoses, peptones, dextrins, maltose, and various hexoses, together with unaltered starch and fats. A noteworthy effect of the acid is the practically complete sterilization of the mixture. It may be mentioned incidentally that there is no absorption through the walls of the stomach except of a trace of alcohol.

The neutralized or slightly alkaline nutritive fluid mixture passes into the intestine to be acted upon by various enzymes with the aid of bile salts. The re-absorption of these bile salts in the lower part of the intestine is an excellent example of the economy which nature, sometimes accused of unnecessary prodigality, can on occasion practise. The principal enzymes supplied at this point are trypsin, erepsin, amylase of pancreatic origin, lactase, invertase, maltase, and lipase. It would be more correct to put some and perhaps all of these in the plural. In the light of present knowledge the action of any one enzyme is probably confined to one of the many substances of the complex and one of the many transformations that substance must undergo in the process of assimilation. "The average atom on its metabolic path within a living cell may be dealt with by more than 100 catalysts in succession."[4]

The hydrolyses of the proteins initiated by the pepsin are speeded up and completed by trypsin and erepsin. The digestion of starches begins in the mouth and, interrupted in the stomach, recommences, and the maltose, sucroses, and lactose are split into the simpler sugars. Nucleo-proteins and other conjugated proteins are dealt with by special proteases. The splitting of fats is assisted by the emulsification of these consequent upon the reduction of surface tension due to the solution of bile salts.

The principal products are amino acids, glucose, soaps, glycerol, with such simple things as the mineral salts taken in with the food which retain their identity or undergo simple reactions to render them more soluble. The movements (peristalsis) of the walls of the intestine thrust the mass forward, and the substances in solution are absorbed through the mucous lining which is permeable by all the now reduced molecules in solution. In the lower part of the intestine the movement is in both directions, so lengthening the time and increasing the completeness of the contact between the solutions and the absorbent mucous membrane. While a considerable amount of water is also absorbed, there is at the same time a certain amount of watery solutions excreted through the walls into the intestinal tract. The contents of the small intestine are thus kept liquid and assisted by the movement and, by diffusion, the process of absorption can proceed towards completion. In the large intestine, on the other hand, there is practically no absorption of food materials even if considerable amounts of these remain in the liquid leaving the ilium. There is however, a rapid removal of water with small quantities of mineral salts, and the residues are thus concentrated to the consistency of fæces.

Having thus sketched roughly the digestive laboratory and the reactions that occur in it, we can consider the materials with which it has to deal. The ordinary crude chemical analysis of a foodstuff describes it in terms of carbohydrates, fats, protein (albuminoid material or better still nitrogenous material), fibre (sometimes called indigestible, or woody, fibre), mineral matters, and water.

Carbohydrate metabolism is the easiest to discuss. The carbohydrates are saccharides, and one of them, glucose, actually finds its way from the food to the blood-stream without undergoing any change. It is, from the point of view of quantities involved, the most important of all the nutrients. All carbohydrate components of the food destined to play an important part in nutrition are gradually hydrolyzed in the process of digestion into their hexose products; and of these the glucoses are the only ones which pass through the mucous lining of the intestine in any quantity. Fructose and galactose are absorbed in very small quantities, pentoses—hydrolysis products of the pentosans, such as the plant mucilages—are absorbed but to a great extent are excreted unchanged. Some portion may undergo oxidation and so economize glucose, but none appears in the reserve materials of the body. This means that there is definite selection on the part of the intestine, for once they have reached the blood all the simple sugars seem to penetrate the tissues with equal facility. Disaccharides cannot pass through the intestinal membrane.

Carbohydrates

In the fasting condition the blood contains about 0·08% (eight parts in 10,000) of glucose. During the period following rapid intake of sugars or raw materials as sources of these, it may rise to 0·13% (13 parts), a very minute rise considering that in a very

short time the blood may take up 100 grams of sugar from one meal. The explanation is the rapid absorption of glucose from the blood by the liver and its transformation into glycogen—animal starch—a polysaccharide closely resembling the erythrodextrins, the first hydrolysis products of starch.

Glycogen also appears in the muscle cells, and as it is used up as a source of energy it is replaced from blood glucose, which in turn is recruited from the glycogen store in the liver, the blood sugar balance being thus maintained. When this source fails the muscle cell can obtain glucose from proteins and possibly from fatty acids.

The maintenance of the blood sugar level is of the highest importance to the organism. Excess of glucose is the condition in diabetes, while deficiency accompanies or is accompanied by equally serious pathological conditions. Milk fever in cows is associated with a low blood sugar. Opinions differ as to whether this is a causative or only an accompanying condition, but the condition of the animal returns to normal upon the injection into the blood stream of glucose. But we are getting away from mere questions of normal nutrition.

A question in carbohydrate digestion which has received a good deal of attention is that of the place of cellulose in nutrition. In man, cellulose, especially if fed in a finely divided state, can only be partially recovered from the fæces, the amount disappearing in various experiments being found to be between 25% and 75%.[5] It is fairly well established, however, that no provision is made for the digestion of cellulose. Traces of cellulases found in the digestive tract have been taken in with the food, and their effect is small. The disappearance of cellulose is really due to the action of intestinal bacteria.[6] The products are chiefly fatty acids together with a considerable amonnt of hydrogen or methane, which being gaseous and inactive with reference to the animal body, make no contribution to the energy supply.

In ruminants the same principle holds that the animal makes no contribution to the hydrolysis of cellulose. The bacterial fermentation, however, takes place to a great extent in the paunch—the first stomach—actually prior to mastication, and the utilization of the end products is more complete than in the non-ruminant.

It is certainly one of the weak points of the ordinary analysis of foodstuffs that it does not differentiate between cellulose and lignin. The latter is not digested by mammals, and as the products would be aromatic alcohols which cannot be assimulated, digestion, if it did occur, would be of no significance to the animal economy.

Before leaving the carbohydrates, one function of fibre should be noted. During the processes of digestion and assimilation the undigested fibre forms a supporting framework for the food mass, and makes it more permeable to the digestive juices. This seems a matter of considerable importance to some of the domestic animals, such as the cow. It is recognized that the food of such animals should have a certain "bulk," chiefly supplied by fibrous foods. In man and other animals excessive fibre is a distinct disadvantage. In the absorptive portion of the digestive tract—the small intestine—the fibre in the mass prevents intimate contact between the intestinal mucus and the digested nutrients, and leads to the appearance of an unduly high proportion of these in the fæces. This means a loss of food material to the organism.

This excreted food material together with glandular substances and mucosa which might otherwise have been retained are partly responsible for the idea that fibre exerts a laxative action. This idea is derived from the quantitatively increased excretion following digestion of unusually fibrous foods, and it is negatived to some extent by the determination of the nature of the increase, *i.e.*, the application of chemical methods. There is, however, a certain laxative effect due to mechanical stimulation of intestinal glands by the irritating presence of fibrous matter, but it is not so great nor so advantageous as would be supposed from mere quantitative data unaccompanied by chemical investigation.

The utilization of fibrous foods such as straw or wood meal had attention in Germany during the war. The most popular product was Kraft Stroh, the result of treating cereal straws with alkali. This would seem to have been utilized to a higher degree than the raw material, but as the product was only 40% of this, it is doubtful if there was any economic or even nutritive improvement. One effect on the animal was an increase in the pentose in the urine. This forms a confirmation of the suggestion that pentoses even if absorbed are not assimilated, and that the small output of pentoses usually found in urine is a true indication of the small extent of the hydrolysis of pentosans in normal conditions.

Although the digestion of cellulose as a source of nutrient material in itself is of small importance to man, the attack of bacteria upon cell membranes may be useful in setting free cell contents which would not otherwise be available in cases where the food swallowed contains a fairly large proportion of entire vegetable cells.

Fats

Fats are essentially triglycerides—esters of the higher fatty acids with the base glycerol. Closely associated with these are lecithins, in which the base is again glycerol but only two units of fatty acids are present, the third hydroxyl of the glycerol being replaced by a phosphoric acid radical which is in turn linked up with a choline base radical:

$$\begin{array}{l} CH_2{\cdot}O{\cdot}CO{\cdot}R' \\ \quad | \\ CH{\cdot}O{\cdot}CO{\cdot}R'' \\ \quad | \\ CH_2{\cdot}O{\cdot}PO(OH){\cdot}O{\cdot}CH_2{\cdot}N(OH){:}(CH_3)_3. \end{array}$$

Lecithin is an extremely important factor in cell metabolism, and is practically the only form in which fats appear in the cell.

The digestion of fats was at one time supposed to be a purely mechanical process, the fat being reduced to a fine emulsion of which the globules could pass the intestinal wall. It has been clearly demonstrated, however, that like other foodstuffs fats must become chemically simplified previous to assimilation. Lipase in the gastric juice can act to a small extent but the real hydrolysis takes place in the intestine after the addition

of bile salts and pancreatic juice. Unless both are present no action takes place. The bile salts bring about emulsion, and the splitting process is carried out by the action of pancreatic lipases, which are, however, activated by some constituent of the bile salts.

In the stomach excessive fat might arrest the digestion of other materials. The slightly alkaline condition of the food entering the stomach would keep the fat emulsion in the condition in which fat is the disperse phase, and the food materials are accessible to the watery solutions of acid and enzymes. A change in the hydrogen ion concentration might have the effect of reversing the emulsion and causing the fat to become the continuous phase and form a protective layer round particles of food. The stomach contents could then become strongly acid and yet fermentation of the food might set in, the acid being unable to pass the fatty envelope and exercise its usual sterilizing effect on the food.

The result of pancreatic hydrolysis of fats is a mixture of soaps and glycerol. The solution of these passes into the circulation and the fats are re-synthesized. This process gives some opportunity for the reconstitution of the fats typical of the body fats of the animal, and the lecithins most suited to it. There is no exclusive selection. The body fat of the pig for example is sensitive to the quantity and quality of the fat in the food and can show, for example, a variation in iodine absorption from 54 to 75, the difference being attributed to the type of fat in the food.

Fats are important to the animal as storage sources of energy, and they are, therefore, synthesized also from glucose. This obviously involves a reduction process, part of the glucose being oxidized by oxygen derived from another part, and a considerable evolution of carbondioxide taking place.

$$6C_6H_{12}O_6 + 13O_2 = 20CO_2 + C_{16}H_{32}O_2 + 20H_2O.$$

Such reactions explain the fact that previous to the winter period the hibernating animal shows an output of carbon dioxide greater than that corresponding to the intake of absorbed inhaled oxygen. There must at the same time be a transformation of carbohydrate or protein to glycerol. Such production of glycerol is noteworthy because when fatty acids are given in the food, instead of complete triglycerides, the absorption is comparatively small, suggesting that the capacity of the body to synthesize the necessary complement of glycerol is also small under these conditions.

The transport of fats from one part of the body to another is preceded by transformation into lecithins.

Sterols

Natural fats of both vegetable and animal kingdoms contain sterols—monohydric alcohols, whose constitution includes both six- and five-membered carbon rings. Little seems to be known about the utilization of the food sterols. The alcohol structure makes the formation of esters easy, but it is probable that the cholesterols in the circulation are to a considerable extent synthesized within the body and are not simple transformations or assimilations of phytosterols (of plants) and cholesterols (of flesh foods) respectively. The ingestion of foods rich in phytosterols is, however, followed by a rise in cholesterol esters in the blood.

A discussion of the non-nitrogenous foods would be incomplete without some reference to alcohol. This adaptable material is not only exceptional in being absorbed by the walls of the stomach and the large intestine, but it can be utilized even when inhaled as vapour. The absorption of the liquid is, however, most rapid in the region of the small intestine where absorption of nutrients in general is most actively carried on. A feature of alcohol assimilation, when not retarded by the presence of a mass of other material, is the rapidity of its utilization. Five minutes after ingestion its effect on the respiratory quotient—the index of oxidative process—is marked, and alcohol is oxidized in preference to fat or carbohydrate. The effect on muscular work is not beneficial, but endurance is said to be increased. The effect on the mentality is well recognized. In moderate dosage, " Inspiration is greater while accuracy is lessened. But, as a poet has pointed out, 'one's effusions can always be proof-read next morning.' "[7]

Proteins

In the case of carbohydrates and fats in foods the problem of supply is simplified by the interchangeability of these both as sources of energy and as substitutes for one another in the formation of storage products, and still further simplified in that even proteins can be used by the organism to replace these other, non-nitrogenous, substances. With regard to the body requirements for actual protein, the problem is a much more difficult one. The call is not a general one for nitrogenous material, but a specific requirement for definite nitrogenous compounds of which certain individuals cannot be produced by synthesis, or by transformation of even closely related bodies.

The effect of the digestive processes upon proteins is to split them up into amino acids. The principal amino acids required in the animal metabolism number about 20, and these must be presented in the correct proportions. It is thus clear that proteins might be ingested in considerable quantity and variety without a balance being attained. Till quite recently it was held that formation of any of the specific amino acids did not occur, but this is rendered rather improbable by the fact that in the haphazard supply of protein of the human diet—especially of the vegetarian diet—the protein balance is established with what must be considered a comparatively small wastage.

The chemistry of the proteins—completely wrapped in mystery until quite recently—has been clarified and systematized by a succession of workers. Modern protein biochemistry owes a great deal to the demonstrations by Van Slyke and Folin and others that the first assimilation of proteins by the blood is in the form of simple amino acids. To say that determining the exact and complete protein or even amino-acid content of any food was probable in the near future is almost certainly grossly optimistic. Investigations of this kind tend to begin with a large quantity of raw material and to end half-way with a small quantity of a tarry-looking mass in the bottom of a very large flask, and which offers very little invitation to further exploration.

However, it is fairly clear that when we wish to discover the ideal protein supply we may well centre our efforts on *finding suitable sources* of the amino acids, tryptophan, tyrosine, cystine, lysine, and probably histidine and proline. The other amino acids required to form by various combinations the body proteins can apparently be manufactured by the body by synthesis or transformations. One of the remarkable things about protein metabolism is tbat the organism which can manufacture alanine, $CH_3 \cdot CH(NH_2) \cdot COOH$ has not learnt to bring about the combination

$$\begin{array}{l} S\text{-}CH_2 \cdot CH(NH_2) \cdot COOH \\ | \qquad\qquad\qquad\qquad\qquad\quad \text{cystine.} \\ S\text{-}CH_2 \cdot CH(NH_2) \cdot COOH. \end{array}$$

Cystine is the important factor in the sulphur metabolism of the body. It is one of the essentials of growth, and enters into the structure of the keratins—horn, hoof, hair, etc.

In the last 25 years chemists have devoted attention to such problems as the kinds of amino acids in plant and animal proteins, the quantitative estimation of these, their digestibility, the problems of synthesis or non-synthesis of amino acids, the final destination of proteins and amino acids in the body, the nutritional value of simple and mixed proteins, tissue waste and its repair, and the effects of protein ingestion on the general metabolism. A great deal of the work has had to be repeated or will be repeated in view of the more recent discoveries of tbe significance of vitamins and minerals in protein nutrition.

The protein requirement of adults, *i.e.*, for tissue repair, does not seem to be so exacting as that required for growth in young animals. The total optimum quantity for adults has been a subject of much, and sometimes acrimonious, discussion. The classical experiments are those of Chittenden, who fonnd he could live on one-third of the accepted standard of about 120 g. protein per day.[8] Benedict (1918), starting out to disprove Chittenden's ideas, became a convert to them. Excessive protein feeding has been found injurious to the kidney, and certain amino acids are held to bring about this injury if excreted in considerable quantity, while others are harmless. The sum of available information suggests that over very long periods of adult life the best protein level is slightly above that reqnired for growth at the maximum rate.[9] General considerations suggest the advisability of finding the optimum quantity of protein and, of any range offered, to choose the minimum. Diminished intake of protein means less formation in the hlood of waste products of acidic nature—uric acid and potassium phosphate as well as purine bases, which help to produce the sensation of fatigue. Protein stimulates the general metabolism, and at the raised level there occurs in the tissues a wastage of energy-producing material. Such are the arguments of the low-protein group. Their opponents start from the knowledge that of the human race, the higher types seem instinctively to select a high-protein diet. They point out that animals will support an unduly low protein intake for 5% of the normal span of life, but this is injurious if continued much beyond that period, and that the longest experiments on human subjects have only lasted about 1% of the natural lifetime.

In attempting to define the usefulness of the nitrogenous portion of a foodstuff, it was at one time assumed that only the digestible true proteins should be taken into account. This followed from the theory that the animal could not synthesize any protein. It is now found that amides can be utilized to build up proteins, and in calculating the protein value of a food for animals, half of the amide content is added to the digestible pure protein, the total being described as the Digestible Protein Equivalent.

An interesting factor in protein nutrition has been named by Rubener (1902), who investigated the point, the specific dynamic action. This means the total energy output following ingestion of a certain amount of food. In addition to the simple output of heat or other energy, each nutrient has a stimulating effect on the cell metabolism. This excess of resultant energy output over the calculated energy value of the food intake may represent a waste of energy reserves if it merely increases unnecessarily the radiation of heat from the body or stimulation of the involuntary muscles. In winter conditions the extra heat may be utilized. The specific dynamic action is about 6% higher in carbohydrate than in fat and about 40% higher in protein than it is in starch. Where rapid output of energy is required there may be something to be said for diets richer in protein than would be indicated by mere body requirements of protein nitrogen.

Mineral Matters

One of the remarkable things about the study of nntrition is the comparative neglect with which the mineral salts and combinations of metallic and non-metallic elements with the organic radicals have been treated. To the chemist this would seem to be an easy side of the snbject to attack, and yet it is only in recent years that the matter has had attention—probably significant evidence that until these recent years the chemist has stood aside and left the study of questions of nutrition to the biologist, and the latter has not been sufficiently alive to the assistance that could be derived by recruiting the chemist in every line of biological research.

Up to about 10 years ago it was the usnal thing to find in any book on the feeding of domestic animals a statement that any well-assorted diet would contain sufficient mineral matter to meet the needs of the animal. Attention was called long ago[10] to the daily requirement by animals of mineral matters, hut this does not seem to have been followed until recently by extensive estimation of the mineral value of foods. In the case of the feeding of domestic animals of the best type involving the use of seed products the natural mineral content of the food tends to be low.

In the human being as in all vertebrates the need of mineral supplies for the young growing individual at least is quite evident, remembering that the skeleton consists chiefly of calcium carbonate, together with two to three times the amount of calcium phosphate. The total calcium amounts to 1·5% and phosphorus 1·0% of the whole body weight. This is by no means

confined to the make up of the skeleton, which, however, does contain 99% of the body calcium and 75% of the phosphorus. Nevertheless 1% of the calcium is quite a considerable amount to be in the circulation and the tissues and in the blood it forms the chief mineral element amounting to 10 to 11 mg. per 100 c.c.

The output of calcium in the lactating animal is enormous. Bunge[11] points out that there is more calcium in milk than there is in lime water, volume for volume, the relative proportions being 1·7 and 1·3 g. per pint. We were once asked whether it were necessary to add calcium to the diet of a cow, which had access to hard water. The answer was "not if she were able to drink thirty gallons of the water for every gallon of milk she gave—and, of course, retain the lime." It is sometimes suggested as a reason for eating whole wheat products that the bran (eliminated in making white flour) is rich in minerals. This is certainly not true with regard to lime, of which bran contains only 0·09% accompanied by 2·9% of phosphorus, which would seem to deprive what little lime is present of whatever value it might otherwise have.

The blood calcium seems to play an important part especially in the transport of phosphorus. It is excreted in the upper intestine and mostly reabsorbed in the lower part of the intestine and the economy is considerable. The total requirement is not high, about 0·6 to 0·7 g. per day in the human adult, but it will be found that many ordinary diets do not supply this amount.

Mellanby[12] points out that some cereals (e.g. oats) depress calcium assimilation. The confirmation or otherwise of this forms an interesting problem for the chemist and biologist.

Potassium and sodium are important elements, but usually plentiful in the diet. Potassium is naturally present in large amounts in vegetables, while sodium is added as sodium chloride. The ratio potassium: sodium in the diet should be about 1·5 : 1.

Iron enters into the problem of nutrition in very minute quantities and its importance in effect seems to be out of all proportion to the quantities involved; 8 to 9 milligrams a day are needed in the human diet and failure to supply this may result in nutritional anæmia. In recent work Steenbock and others (J. Biol. Chem., 77, 769 etc.) found that diets rich in pure iron salts were not capable of preventing anæmia but the addition of slight traces of copper was beneficial.

The necessity for a supply of iodine has been made very clear in recent years. Its close connexion with the activity of the thyroid gland gives it importance as one of the keys to both growth and intelligence. The administration of iodine in Switzerland has wiped out cretinism—the imbecile dwarf condition—and the importance of the achievement may be realized by the consideration that a few years ago the comparatively small population of Switzerland included 50,000 cretins. In considerable districts, especially in the U.S.A., the occurrence of goitre has been similarly checked. It is rather astonishing that iodine deficiency exists at all, the requirement being in the region of one two-hundredth of a milligram a day, and that it can be successfully taken up by the thyroid gland if fed in the simple form of potassium iodide.

It is well established that increased fat metabolism involves increased iodine intake, and also that iodine exercises some control on calcium metabolism. A point of great interest is the capacity of the thyroid to store iodine, the dried tissue of the gland containing amounts which may vary from 0·1 to 1·0% of iodine.

Phosphorus is exceedingly important in the general metabolism as well as in the avoidance of certain deficiency diseases such as rickets. It is found in the constitution of many of the body proteins as well as in the lipoids. It takes part in the step down from glycogen to lactic acid in muscular action and forms part of the lecithins which are the chief means of transport of the fats in the body.

The study of mineral requirement of animals has had many important economic results. Some examples have been mentioned above and as an interesting example we might mention the investigation of the mineral loss in perspiration in miners. When this was made good in the drinking water, fatigue was not so rapid in onset nor so distressing as it had formerly been.

Vitamins

These have been given so much publicity recently that a bare mention will probably suffice. The chemist seems to have caught up the biologist, and to be able to supply nearly as clear an idea of their constitution as his colleague can of their specific functions. A great deal has to be done which requires the closest co-operation of both sciences. For example, the nature of the way they act requires elucidation. Some years ago now, something like a war raged between the exponents of the vitamin theory and the somewhat conservative chemists. One incident has always amused me in the recollection. The Southern Army had found that growth and a non-rachitic condition followed the feeding of small animals on a diet including the green outer leaves of cabbage, but that these could not be maintained when the white inner leaves were substituted for the green outer ones. Ergo—the green leaves contained vitamins—connected with sunlight—the others had none. The general of the Northern Army, on hearing this trumpet blast, at once sent out for a cabbage, submitted it to an ordinary chemical analysis, and showed that the calcium was concentrated in the outer leaves and missing from the heart leaves—an excellent counterblast.

Nowadays the two armies fraternize and exchange ammunition and even whole battalions of workers like the good allies they have become.

REFERENCES

1 McCay, "The Protein Element in Nutrition."
2 Hindhede, "Protein and Nutrition."
3 E. F. Armstrong, 1904.
4 Hopkins, "Specificity in Biochemical Catalysts," 1931.
5 Kohmoto and Sakaguchi, Journal of Biochemistry, Japan, 6, 61.
6 McCance and Lawrence, "The Carbohydrate Content of Foods," 1929.
7 Cameron, "Textbook of Biochemistry," 1932.
8 Chittenden, "Physiological Economy in Nutrition," 1904.
9 McCollum and Simmonds, "The Newer Knowledge of Nutrition," 1924.
10 K llner, "Scientific Feeding of Animals."
11 Physiol. and Patholog. Chem., 1902.
12 Mellanby, "Experimental Rickets," 1925.

SOCIETY OF CHEMICAL INDUSTRY

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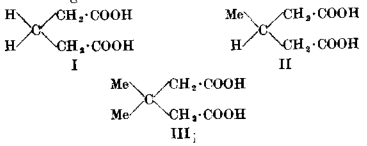
SOUTH WALES SECTION

A joint meeting of the Section with the Institute of Chemistry was held on February 24 at the Cardiff Technical College, when a paper on "Stability of Cyclic Compounds" was given by Dr. F. J. F. Dippy. In this paper Dr. Dippy said that in the year 1885 W. H. Perkin, jr, published his first work upon the syntheses of closed carbon-chains, by which he sought to demonstrate that rings possessing fewer than six members were capable of existence. This revolutionary departure was crowned with success, so much so that even conservative opponents of the view, such as Victor Meyer, acclaimed and accepted Perkin's work. In a relatively short time three, four, and five-membered rings had been synthesized. An outcome of this work was the development of Baeyer's "Strain Theory" which attempted to relate the stability of a cyclic compound with the strain set np between the inter-valency angles as a result of the departure from the normal tetrahedral confignration. This theory, although applicable to the simplest cases did not explain satisfactorily the stability of most alicyclic systems, since, in particular, it failed to take into account the influence of substituent groups in a system. This fact was demonstrated by Thorpe and Ingold. It followed as a result, that the angle between any two valencies of a carbon atom was determined by the mode of combination of the other two valencies, that is, by the bulks of the attached groups. Ingold gave to this modification of Baeyer's theory a limited quantitative basis. Much experimental snpport, both chemical and physical, had been adduced in favour of this newer form of the Strain Theory, which was now termed the Valency Deflexion Hypothesis. The principle was clearly illustrated in the tendency to cyclopropane ring formation of the α-bromo derivatives of the following clutaric acids:



I II III

In accordance with the Hypothesis the tendency was III > II > I

Criticisms had, however, been levelled at the Valency Deflexion Hypothesis, for there existed undoubted weaknesses in its application. Exception had been taken to the assumptions involved in Ingold's calculations. An outstanding difficulty must certainly arise in the use of any cyclic-strain theory based entirely upon spacial considerations; the substituents in a system while possessing bulk also possessed polar character, a factor that might easily affect the course of a reaction which was being accepted as a measnre of ring stability. This, doubtless, had been the militating factor in many reactions which have been accounted anomalous. To distinguish between spacial and polar effects was indeed a problem, and it was at present recognized that any satisfactory strain theory must take both into account. In certain recent papers attempts had actually been made to trace the superposition of polar upon spacial effects.

Of later years interest had centred around the preparation, by Ruzicka and co-workers, of high-membered carbon rings of great stability; a ring with as many as 32 members had been obtained. The remarkable stability of such rings was easily understood by assuming that the rings of six and more members tended to relieve their internal strain by distortion from the planar condition. This extension of the Valency Deflexion Hypothesis, termed the Sachse-Mohr Theory, had been given conclusive proof, as for instance the isolation of the cis and trans forms of decalin. The connecting link between the planar low-membered and the distorted high-membered forms was the six-membered ring. The present view, due to Baker and Ingold, was that this ring did buckle but possessed strain since it was in constant oscillation between the two stabilized extremes (cis and trans), which therefore introduced a strained planar phase. This conception was in agreement with the facts and had received a measure of experimental support.

The present state of the whole subject of the stability of cyclic compounds was that the Valency Deflexion Hypothesis in its widest form was capable of co-ordinating the plain facts of alicyclic ring stability when it was possible to apply it in conjunctiou with polar considerations.

Dr. Watson, Mr. J. C. Roberts, and Mr. E. A. Rndge contributed to the discussion which followed the reading of the paper.

YORKSHIRE SECTION

In co-operation with the Refractories Association of Great Britain, a meeting of the Yorkshire Section of the Society was held on Friday, February 17, at the Royal Victoria Hotel, Sheffield, when two papers were read, namely, "The Reactivity of Cokes at Low Temperatures," by Mr. C. B. Bolland and Prof. J. W. Cobb, and "Some Characteristics of the Clays Used in Manufacturing Runners, Stoppers, and Nozzles," by Mr. J. E. Priestley and Mr. W. J. Rees.

The following is a summary of the first paper:

Cokes prepared from New Hucknall medium caking coal at 630°, 725°, 815°, 920°, and 980° C. were used in the determination of reactivities to CO_2 at 600° C.

The reactivities of the cokes decreased with the temperature of carbonization.

A new method for determining reactivities to oxygen at low temperatures was described, in which air was passed at the rate of 200 c.c./hr. over 0·4 gram of graded coke (5–10 I.M.M.) packed in a V-shaped silica tube immersed in a molten lead bath maintained at the experimental temperature. The high thermal capacity and conductivity of the molten lead enabled the heat evolved by the exothermic reaction between coke and oxygen to be dissipated, so that the temperature of the coke column could be kept constant. A continuous sample of the exit gas was taken and analysed. The reactivity was measured by:

$$\% \; O_2 \text{ consumed} = \frac{\% \; CO_2 + \frac{1}{2}\% \; CO}{\% \; CO_2 + \frac{1}{2}\% \; CO + \% \; O_2}.$$

The reactivities to oxygen of cokes made at 600°, 800°, and 1150°, from four types of coal, Sharlston Wallsend (strongly caking coal), New Hucknall (medium caking coal), anthracite, and lignite, were determined at temperatures between 250° and 650° C. For cokes prepared from a particular coal, the reactivity decreased as the temperature of carbonization increased. For cokes prepared at a definite temperature, the reactivities increased in the order anthracite, Sharlston Wallsend, New Hucknall, and lignite.

The ignition temperatures and repeat ignition temperatures of the cokes were determined. The repeat ignition temperature is that obtained after a previous regulated ignition of the coke. Both the ignition temperatures and repeat ignition temperatures could be correlated, although not quantitatively, with oxygen reactivities measured at low temperatures.

Heating the 600° coke, from any particular coal, at 800° and 1000° raised the ignition temperature quickly, and the repeat ignition temperature more slowly, to values similar to those of cokes made at 800° and 1000°. The ignition temperature determinations and reactivities to oxygen carried out on preheated cokes suggested that the influence of heat was mainly a surface effect, the molecular groups on the surface being more affected by the heat treatment than those below the surface.

In the discussion which followed, Mr. R. A. Mott said that no property of coke had attracted so much attention as its reactivity, but in view of the number of discordant and unexplained results the literature reflected badly on chemistry. The Leeds school, however, had not followed conventional methods, and had already made important contributions to a real knowledge of the phenomena involved. The present method was an ingenious solution of the problem of determining reactivities to oxygen.

Mr. Tucker asked whether the third and fourth ignition temperatures had been determined, and what relation these bore to the second ignition temperature. Mr. Bolland replied that these had been found to be the same. Mr. A. H. B. Cross asked whether the authors considered the first, or the second, or later ignition temperatures to be of most importance. The second ignition temperature might be typical of the material below the surface layer, but from an industrial standpoint the first ignition temperature seemed to be equally important, as in a furnace using coke it was conceivable that the heat generated by the combustion of the surface material might raise the temperature of the material immediately below the surface layer to that of the second ignition temperature. In such a case combustion of the coke would proceed, and the reactivity would appear to be related to the first rather than to the second ignition temperature. In reply Prof. Cobb said that the second ignition temperature was more important in that it afforded a clearer indication of the properties of the coke as a whole, and not simply of the surface film; it was related more closely than the first ignition temperature to reactivity determinations which were concerned with the coke below the surface film. The first ignition temperature was of importance, however, when the first phenomenon that could occur in the combustion of coke was being considered.

Mr. H. J. Hodsman advocated a stricter use of the word "reactivity," which should preferably be reserved for the chemical reactivities to CO_2, H_2O, and O_2—three different reactivities which were not necessarily parallel. Reactivity was not determined by temperature of carbonization alone. A coke from petroleum stills, said not to have exceeded 450° C., was found to be less reactive to CO_2 than a Durham coke, whilst one of the most reactive cokes tested was prepared in horizontal gas retorts. By taking account of the reactivity and of the physical properties of a coke it was possible, from a laboratory examination, in a large measure to predict its behaviour in use.

Introducing the second paper Mr. W. J. Rees said that the investigation had been started because of the need of information on the characteristics of the comparatively cheap clays employed in the accessory plant for the casting of steel. A large proportion of defects in ingots were due to the inclusion of refractory from runners, sleeves, etc. in the steel, and little information had been found as to why the refractory entered the steel. Mr. J. E. Priestley described the details of a survey of the characteristics of typical clays used in the manufacture of runners, sleeves, stoppers, and nozzles. Test-pieces taken at works from extruded runners and moulded sleeves were fired at various temperatures in the laboratory, and the moisture content, firing data, porosity, specific gravity, refractoriness, refractoriness under load, and thermal expansion were determined. A comparison was also made of test-pieces fired in the laboratory and under works conditions.

In the discussion which followed Prof. Cobb said that the vital property required of these products was the capacity to resist thermal shock, which would be indicated considerably, but not completely, by the determination of the reversible thermal expansion of the fired clays. In the case of a material subjected to rapid changes of temperature two phenomena had to be considered, viz. the stress set up in the material by the alteration in dimensions, and along with this, the power of the material to resist the stress. At high temperatures the refractory might be sufficiently plastic to accommodate the stress; at lower temperatures, when the material was almost perfectly rigid, the stress would not be dissipated in this manner, but might be

sufficient to cause breakage. The distorting force created in the materials by rapid temperature changes was mainly a shearing stress, consequently precise information would be obtained from an examination of the behaviour of the materials under torsional stress at different temperatures. A most useful combination would be the examination of both thermal expansion and behaviour under torsion.

Mr. W. J. Rees agreed that a combined investigation of the thermal expansion and behaviour under torsion of the materials would be especially applicable to the assessment of the resistance of the products to "tearing" stresses, particularly when supplemented by an examination of the materials under tensile stress. In extending the work he hoped to study the behaviour of the various materials under torsion and under tensile stress.

The optimum firing temperature for the clays described was necessarily a compromise; lightly-fired materials would be more resistant to thermal shock, but hard-firing was necessary to give resistance to "tearing" stresses. He hoped that the best firing temperature would be indicated in future work.

Dr. A. L. Roberts asked how the properties of the materials burned in the laboratory compared with those of the works-fired products, as a method of laboratory firing which produced products comparable with those burned under industrial conditions would be of value. In reply Mr. Priestley said the properties of the experimentally and works-fired clays showed good agreement.

CHEMICAL SOCIETY

The following is an account of the continuation of the discussion, on February 16, on "The Raman effect in relation to some chemical problems" (see p. 161):

Sir Robert Robertson called attention to some of the features of Dr. Fox's introduction to the Discussion, such as the simple and attractive apparatus for obtaining the Raman effect, and the importance of this effect in two main directions, namely, for throwing light on the dynamics of the molecule and as a diagnostic means of determining the presence of chemical radicals. He recounted briefly the position of affairs immediately after the publication of Raman's paper, when claims were made for the replacement of work in the infra-red by the Raman spectra, followed by the dramatic discovery of a Raman line previously indicated by Schaeffer as an inactive frequency, until it became clear that progress in molecular dynamics would take place when information from the two sources—infra-red spectroscopy and Raman differences—were considered together.

He asked Dr. Fox if he could explain the following point. In the vibration-rotation band of HCl a distinct minimum occurs at 3·46 μ which can be interpreted as the place where there is no change in rotation. It was at exactly this place that Wood found an inactive frequency indicated by a Raman difference. Now in the case of the band at 3 μ of ammonia a Raman difference has been found, but the infra-red spectrum here shows a strong Q branch or a distinct active optical frequency, the difference between the spectra of the two gases being that whereas both are associated with a Raman frequency yet in HCl there is a missing line in the infra-red showing no transition in rotation, and in NH_3 a powerful line also in the infra-red where there is no change of rotation.

Prof. W. E. Garner said: If the symmetry of a molecule is modified on replacement of one group by another, then the new Raman or infra-red lines which appear are not necessarily due to the vibrations of the substituting group. On replacing H by OH and NH_2, the new lines cannot be ascribed with certainty to the OH and NH linkages respectively. The fact that the oxygen and nitrogen linkages do not lie in the same straight line causes a modification of symmetry, rendering vibrations active which were hitherto inactive. Even in the case of chloro-compounds, the introduction of chlorine into organic molecules can cause the appearance of vibrations of the organic radical which were previously inactive. Thus, Mecke (Z. phys. Chem., 1932, **B, 17,** 1) has shown that the introduction of chlorine into acetylene, ethylene and ethane gives rise to new Raman lines which are due to vibrations of the molecule as a whole.

It follows, therefore, that the absence of a particular line in the spectrum of a compound cannot be taken as proof of the absence of a particular group from the molecule.

Prof. T. M. Lowry said that Mr. Sutherland had recently completed in Ann Arbor an investigation of the Raman spectrum of nitrogen peroxide which had been begun at his suggestion in the Laboratory of Physical Chemistry at Cambridge. Twelve different types of vibration of the N_2O_4 molecule are possible, of which 11 have been identified in the infra-red and Raman spectra. The most interesting of these involves the oscillation of the two halves of the molecule under the control of the median bond. In accordance with the ease of dissociation of the molecule, this is the lowest frequency of the whole series.

Mr. C. R. Bailey said: Dadieu and Kohlrausch's expression for the binding force appears as $fa/2$, where a is the amplitude of vibration at the point where dissociation may be regarded as having taken place. From first principles it would seem that the quasi-elastic force between the constituent atoms or groups for infinitesimal vibrations must be a better measure of the binding force than any quantity involving the second parameter, and, as evaluated by Dadieu and Kohlrausch, the relation involves the expression for the potential energy ($U = \frac{1}{2}fa^2$). Now $f.r$ is given by $-dU/dr$, and consideration of a typical potential energy ($U : r$) curve shows that this slope is first negative, then positive, and its linearity in the neighbourhood of the equilibrium interatomic separation is a test of the harmonicity of the vibrations. The potential energy expression above can only hold in this narrow region, and can have little significance in its simple form when transferred to a place at which an entirely different force law holds.

It is, perhaps, not generally realised how close is the relationship between the work of dissociation and the force constant in allied molecules. Morse has derived an expression for the potential energy of a molecule which fits the experimental results: it is $U = E + D[1 - \varepsilon^{-b(r - r_e)}]^2$, and from it may be

deduced the energy of dissociation, $D = \frac{\omega^2}{4x\omega}$ cm.$^{-1}$, and the frequency for infinitesimal amplitudes,

$\omega = \frac{b}{2\pi}\sqrt{\frac{2D}{\mu}}$ cm.$^{-1}$, where U is the potential energy of the molecule, E the electronic energy, r the interatomic separation, and r_e the equilibrium distance, and b is a constant. On comparison with the formula for the frequency of vibration of a particle under an elastic force, $\omega = \frac{1}{2\pi}\sqrt{\frac{f}{\mu}}$, it will be seen that for simple molecules and groups, D is proportional to f. Two cases may be cited: the ratio of the force constants for CO and CO_2 is 18·8/14·2 = 1·3, while the ratio of the heats of linking is 237/182 = 1·3; the corresponding values for CS and CS_2 are 8·4/6·9 = 1·2, and 158/132 = 1·2.

The absolute value of the force constant provides a clue as to the type of bonding in a molecule. The normal triple bond (N_2) has a force constant of some 22×10^5 dynes/cm., the double bond of 14 (NO, CO_2), and the single bond of 7 (Cl_2O). When the molecular properfunctions are of both the localised and non-localised types we have intermediate values (SO_2, and the nitro-group are both 9×10^5 dynes/cm.). In this way it can be shown that the structural formula of nitrous oxide is N = N = O.

The complementary nature of the results of Raman and infra-red investigations is well illustrated by the case of nitrogen dioxide. NO_2 has a simple infra-red *spectrum characteristic of a rectilinear molecule with* two optically active fundamental vibrations at 6·17 and 15·6 μ. The position of the optically inactive fundamental can be calculated as approximately 10·6 μ; this is the Raman displacement of some 940 cm.$^{-1}$, which however has not yet been experimentally determined. But *the force constants indicate single linkings between the* central nitrogen atom and the external oxygen atoms; the molecule is "odd" with seven bonding electrons, and if another electron is added we have the nitrite ion, which should again be rectilinear, but with double bonds between the central and external atoms. By *allowing for this difference in the force constants,* we can calculate the frequency of the inactive vibration, as some 1313 cm.$^{-1}$, and we can predict that the Raman spectrum of, say, an aqueous solution of an inorganic nitrite should show an intense line with this displacement. Dadieu and Kohlrausch find that the nitrites of sodium, potassium, calcium, and barium all have a very strong line at 1360 cm.$^{-1}$.

Dr. C. P. Snow said: I would make the tentative suggestion that the data of Raman scattering provide a clue for the assignment of electronic states of some polyatomic molecules. For instance, the CO group in aldehydes and ketones is, from the experimental facts, definitely responsible for a Raman line of 1710 cm.$^{-1}$ with a negligibly small variation (see the collected results in Kohlrausch's monograph on the Smekal–Raman effect). This can only mean that the electronic binding (*i.e.*, the quantum number of the electrons) between the C and O atoms is appreciably the same through a large number of molecules. If we consider the way in which two electrons from the CO group are combined with, *e.g.*, *two electrons from the other carbon atoms in acetone*, it becomes probable that the molecular electrons of the CO group are in much the same state as in an *excited CO molecule. On comparing the first excited* state of the CO molecule with the CO group in aldehydes and ketones, we find a striking resemblance in *physical constants. The effective vibration frequency* for $^3\Pi$ CO is 1712 cm.$^{-1}$ (cf. 1710 cm.$^{-1}$ for aldehydes and ketones). The most favoured electronic transition of *$^3\Pi$ CO is $^3\Pi \rightarrow {}^3\Sigma$ in absorption, with origin at* 35,400 cm.$^{-1}$ (cf. the band head of c. 34,800 cm.$^{-1}$ found invariably for aldehydes and ketones). The slight paramag*netic contribution of the —CO group to the susceptibility* of aldehydes and ketones is in agreement with the suggestion; the analysis of the fine structure of the electronic *bands is not far enough advanced to give a definite* answer, but the general character of the bands, the difference between the structure in formaldehyde and *the continuous band in acetone, the resemblance between* the formaldehyde and acetaldehyde structures, and the photochemical decomposition of formaldehyde all give *strong support to the idea of a $^3\Pi$ CO group existing in* aldehydes and ketones, modified in the case of aldehydes by the converted 1*s* electrons from the hydrogen atom. *A similar consideration applies to CN, NO, and N_2* groups, and can probably be generalised further. This work is being completed; if the suggestion can be *applied in the way proposed it will be possible:*

(1) to account for the electronic transitions of a number of polyatomic molecules (this is essential from the *physical* side; so far we have no idea of the nature of the electronic transition for a single polyatomic molecule).

(2) to give quantum numbers to the electrons of the chemical bonds in a number of molecules, and thus to provide a physical basis for the *chemical* differences. This would allow us to see the physical differences in the electrons of the CO group in aldehydes and esters, for example; and to express quantitatively the subtle difference between aldehyde and ketone.

Dr. H. J. Emeléus drew attention to the possibility of settling problems of constitution in organic and inorganic compounds from Raman spectrum work. For example, hydrocyanic acid gives Raman displacements characteristic of the nitrile and of the *isonitrile* form, whilst acetoacetic ester exhibits frequencies characteristic of the C = O (ketone), C = O (ester), C = C, and (OH) linkages. Among inorganic compounds there is similar evidence of the formation of the molecules $SnCl_3Br$, $SnCl_2Br_2$, and $SnClBr_3$ in mixtures of $SnCl_4$ and $SnBr_4$. *Liquid He at 1·9° Abs. is stated by McLennan to give* "wings" on the undisplaced line, which may be due to rotational frequencies in a loosely bound He_2 molecule.

Mr. W. F. K. Wynne-Jones also spoke.

Dr. J. J. Fox replied as follows: It is not difficult to see in a general way that Raman lines may occur when the infra-red spectrum does not give a vibrational band. The HCl vibration-rotation band at 3·46 μ represents a "parallel" band, the missing central line corresponding to that part of the vibration-rotation combination for which no change of rotation occurs. This is so rare

an occurrence that there are not sufficient molecules in this condition to produce an absorption band. Now Raman lines require that the molecule shall have an energy level (l) from which it can pass to two other levels (m and n). The difference in these other two levels may or may not be coincident with an infra-red absorption band, but for the Raman line to appear it is not a necessary condition that such an absorption band shall be found. If there is a possibility of the transition from the l to m and l to n, the difference will occur in the Raman spectrum, more particularly if no displacement of the electric moment arises in these transitions and the line is not a combination line. This implies that when an infra-red absorption band agrees with a Raman line, as in NH_3, the mechanism whereby the final stage is reached is not quite the same in the two cases. The Raman line is more nearly that arising from a harmonic vibration, whereas the absorption band is in general an anharmonic vibration.

The appearance of several new lines on substitution of, say, —OH for —H in a compound cannot at present be accounted for on theoretical grounds. In a sense these new lines are not unexpected as a result of the extra complications introduced into the molecule by substitution.

It must be accepted that the "force constant" of the simple formula used in introducing the discussion might be replaced by the expressions derived from the spectroscopy of the simpler molecules; but in considering more complicated molecules, it is not possible as yet to take advantage of this in calculating the relationships of the force constants for different types of linkages in the same molecule. While a group of atoms—usually two—can therefore be considered as if they were isolated to a large extent, the effect of the rest of the molecule on the vibration of such a group cannot, of course, be left out of consideration. The small variations in the Raman frequencies for the same group in different compounds are undoubtedly connected with the nature of the molecule and its constituent parts, and these variations will probably be found to have definite significance for the structure of the molecule. It is to be emphasised, however, that in similar types of compounds, *e.g.*, aldehydes and ketones, the rest of the molecule seems to have little or no effect on the particular vibration concerned and the method of approach to this subject is doubtless that indicated by Dr. Snow.

McLennan observed some indication of a Raman effect suggesting a quasi-rotation with liquid helium, but this is altogether different from the definite and sharp vibration lines fonnd with other simple diatomic molecules. It seems to indicate that at these low temperatures the He atoms may approach so closely that van der Waals forces operate to produce a condition which resembles a molecule more or less, a very different state of affairs from a molecule of nitrogen, for example, which has a definite vibration frequency for the motion along the line joining the two nuclei.

It seems very likely that the appearance of new lines in mixtures of metallic tetrahalides is an indication of the formation of new compounds, for it is known that the Raman vibrations are altered in compounds by changing the halogen. Until such bodies are isolated, however, and their Raman spectra determined, there is no sure means of establishing the existence of such new mixed halides in the mixture. I would not expect that the proportion of the new constituents in such a mixture could be determined closer than a few per cent. from examining the intensity of the lines.

It is not safe in this kind of work to pass from a consideration of the dissociation of nitric acid to some other acid such as iodoacetic. The interesting feature in nitric acid is the behaviour of the line at 1300 to 1400 cm.$^{-1}$ of the $-NO_2$ group, a line found in many solid nitrates and in 100% nitric acid. It is the variation of this line on dilution which calls for study, and as far as I am aware this feature is not found with other strong acids so far studied.

I would make a plea here for very careful consideration of the scope of new work on the Raman effect so far as it affects chemical problems. It is fairly easy to take photographs of a number of substances, but it seems to me to be much more important at the moment to examine a few compounds thoroughly in order to determine the relative intensities of the Raman lines and more especially to investigate the state of polarisation of he different lines in similar types of compound.

FEDERAL COUNCIL FOR CHEMISTRY

EXTRACTS FROM THE REPORT FOR THE YEAR 1932

INTERNATIONAL AFFAIRS

In the last report it was stated that, owing to the world-wide situation, the Ninth International Congress of Pure and Applied Chemistry, arranged by the National Council of the Spanish Federation of Chemical Societies to take place in Madrid in April, 1932, and to be followed by the Eleventh Conference of the International Union of Chemistry, had been postponed. Although regretting the necessity for arriving at this conclusion, the Federal Council expressed full agreement with the decision taken and conveyed its sympathy to the National Council in Madrid.

Following the postponement of the meeting, which has necessarily curtailed the activities of the International Union during 1932, authority was sought and given by the Adherent Bodies of the Union for the Bureau to exercise the powers of the Council until the next meeting of the Union which is to take place in the spring of 1934 in Madrid, and not in Switzerland, as previously arranged.

Chemical documentation.—A conference summoned by the Office International de Chimie was held in Paris in October, at which Prof. J. C. Philip was present, to consider the question of chemical documentation, which embraces the registration, collection, and dissemination of chemical knowledge in the widest sense. It was decided that the Office International de Chimie should prepare a directory of the centres of chemical documentation in the different countries, with information as to the activities of each centre, and the Federal Council has agreed to render any assistance within its power when required, but to accept no financial liability.

Organic nomenclature.—In 1931 the Federal Council made an official protest to the International Union

with *regard to the findings* of the International Committee *dealing with the reform of biochemical* nomenclature inasmuch as these did not represent the opinions of the national committees, and has further protested *against the use of the term "glucides"* in the "Rapports sur les Hydrates de Carbone (Glucides)," issued subsequently.

Home Affairs

The Council has to record its profound regret at the death of Mr. Alfred Chaston Chapman, F.R.S., who represented the Institute of Brewing on the Council for many years. Mr. Chaston Chapman's wide scientific attainments and knowledge of scientific men and affairs proved of particular value in the work of the Council. The Council mourns the loss of a distinguished colleague who, by his great personal qualities, had endeared himself to all those with whom he came into contact. The sympathy of the Council was conveyed to Mrs. Chaston Chapman by the honorary secretary.

It is satisfactory to report that the efforts of the British Standards Institution to extend the use of the words "British Standard" to include "Chemical substances used in manufactures, photography, or philosophic research and anti-corrosives" have been approved by the Board of Trade, which agreed to the Institution proceeding with an application to register, provided that it was in a position to submit support from the appropriate trade association or similar body. The Federal Council gave its support to the application.

In October a committee consisting of Dr. E. F. Armstrong, Mr. E. R. Bolton, Dr. L. H. Lampitt, Prof. G. T. Morgan, Mr. Emile Mond, Prof. J. C. Philip, Sir William Pope, Mr. J. Davidson Pratt, and Mr. W. Rintoul was appointed "To consider how the resources of the various bodies concerned with the professional and scientific welfare of chemists can be most economically and efficiently utilized." This Committee has met on several occasions, and will present, early in 1933, a report on its findings for consideration by the Federal Council.

Finance

The Statement of Receipts and Payments for 1932 showed a balance of £145 13s. 11d. The sum received from the constituent organizations was £59 8s., as against £218 in 1931, and there appeared an item of £50 10s. 1d. representing income tax recovered. A special item of expenditure was £41 2s. for accountants' charges in connexion with the prolonged negotiations with the Inland Revenue authorities in establishing the claim of the Federal Council to be deemed a charitable society and, therefore, exempt from paying income tax, and in recovering income tax from 1922 to 1932. In future, the income tax will be recovered by the treasurer.

The Federal Council desires to express its appreciative thanks to those of its constituent organizations who have contributed for 1932.

ROYAL INSTITUTION

At a meeting of the Royal Institution on February 24 a discourse was given by Prof. W. A. Bone, F.R.S., on "The Photographic Analysis of Explosion Flames," accompanied by a number of interesting demonstration experiments. Prof. Bone said that nowadays the photographic analysis of explosion flames had become an indispensable part of the scientific study of explosions which recent events had rendered more necessary than ever for public safety and well-being. After describing, with experimental illustrations, how the earlier work of Mallard and Le Chatelier and of Berthelot and Vieille in France, as well as of H. B. Dixon and collaborators in this country, during the period 1883—1903, had revealed not only the successive stages in gaseous explosions but much about the nature of the final phase of "detonation" with its intensive chemical action, high constant velocities (one or two metres per second) and shattering effects, he proceeded to deal principally with recent developments in the designing of high-speed cameras made by Mr. R. P. Fraser at the Imperial College, South Kensington. It had now become possible not only to photograph, but also to analyse with precision, periodic movements in explosion flames occurring with frequencies up to a million per second.

The method employed to-day was in principle the same as that originally devised by Mallard and Le Chatelier, namely photographing on a plate or film moving vertically with constant velocity, the movement of the flame along a horizontal tube. The chief difference was that to-day highly-sensitized films were moved vertically at any constant speed up to 200 m. per second, instead of using a plate moving at 1 m. per second.

A number of the resulting photographs were exhibited showing (i) the influence of compression waves in accelerating explosion flames and setting up detonation therein and more particularly (ii) the new phenomenon of "spin" in detonation, which, said Prof. Bone, was due to a highly luminous comet-like "head" of detonation spiralling through the medium with a frequency of several tens of thousands a second, and which appeared to be a concentrated locus of positively charged particles. These developments had opened up a new field in the investigation of the propagation of chemical change through gaseous media under the most intensive conditions of temperature and pressure.

In order to illustrate the flame movements occurring when an explosive mixture of gas is ignited, some experiments were made with such explosive mixtures in a horizontal glass tube, 20 ft. long and 2 in. in diameter, fitted at one end with a device enabling it to be quickly filled with gas. Using mixtures of suitable gases it was shown that in the initial stages there is a "uniform movement" succeeded by an "oscillatory period." The final stage of violent "detonation" was demonstrated by firing a moist mixture of $2CO + O_2$ in a leaden coil fitted with a "detonation box" and terminating in a closed glass tube, which was shattered by the force of the explosion.

In dealing with the phenomenon of "spin" in detonation, it was shown this is due to a material "head" of detonation spiralling down the tube along a helical track. This was demonstrated by the detonation of an explosive $2CO + O_2$ mixture in a tube with a thin film of lead on the inner surface, the "head" volatilizing the lead particles in its path, and so leaving a record of its helical track.

SOCIETY OF GLASS TECHNOLOGY

The 151st meeting of the Society of Glass Technology was held in Sheffield on February 15, 1933, the President, Mr. Edward Meigh, M.B.E., M.Sc., in the chair. Two papers were presented and discussed:

(*a*) "The Application of Statistical Method to the Quality Control of Manufactured Products," by Bernard B. Dudding, M.B.E. Mr. Dudding said that a recent paper by Dr. Egon Pearson read before the Royal Statistical Society made his own paper somewhat redundant. The Glass Standards Committee of the Society, however, had been engaged in some experimental work on the thermal endurance of rods of a commercial glass, and had suggested that the data obtained in that work might form the basis of a paper on statistical methods. The paper outlined the premises on which the application of statistics was based and warned users of the dangers of ignoring these assumptions.

Mr. Dudding described the construction of graphical control charts like those introduced by Shewhart, suited to the study of the results from routine testing on small sample batches selected from manufactured products. An alternative method due to Fisher for testing the consistency of results more suited to isolated experiments was given.

The data were also utilized to describe the methods which could be used to determine (*a*) the degree of association existing between two variables, (*b*) the relation which exists between them.

Finally Fisher's Z′ function was used to test consistency between results obtained from different groups of samples.

(*b*) "A Study of the Volatilization Losses from Glasses Containing Potash and Silica," by E. Preston, B.Sc., and Prof. W. E. S. Turner. In a manner similar to that used in the authors' previous study of volatilization from pure soda–silica glasses, the volatilization of potash from a series of pure potash–silica glasses had been investigated. The glasses were prepared by melting in platinum, and were found to be difficult to prepare and preserve. Whilst being much more viscous than the corresponding soda glasses, they are of very inferior durability, and could only be preserved in dry CO_2-free air, except the very high silica glasses, 90%, 85%, and 80% SiO_2, which were quite durable.

The volatilization losses determined at 1400° and 1300° showed that whilst no sharp separation into two groups of glasses occurred, as with the soda–silica series, nevertheless evidence was not lacking that the compounds potassium-quad-silicate $K_2O \cdot 4SiO_2$, and potassium disilicate $K_2O \cdot 2SiO_2$, had existence in the molten state at these temperatures. The volatilization losses for the whole series suggested an unknown but presumably extensive dissociation of the quad-silicate in liquid solution.

The variation of the temperature coefficient of volatilization from 1400° to 1300° seemed capable of explanation in the light of the equilibrium diagram for this two-component system when the two compounds were assumed to be present in the melt, the disilicate having a temperature coefficient approximately only half that of the quad-silicate. Comparison of the initial rates of loss with those of the soda–silica series showed that below 30%, approximately, of either alkali the ratio of the loss of potash to the loss of soda was less that the ratio of the respective molecular weights, viz., 1 : 1·51, but above about 30% of alkali the ratio of the losses was greater than the ratio of the molecular weights.

OBITUARY

Dr. ALFRED RÉE

By the death on February 26 of Dr. Alfred Rée, industry in this country has lost one who for many years has been a notable leader. The chemical industry in particular has lost one of its most tireless workers, and this Society must record with much regret the passing of one of its oldest and most distinguished members. Dr. Rée joined the Society in 1886 and during the years 1919–21 acted as Vice-President.

Dr. Rée was born in Leeds and educated at the Bradford Grammar School, afterwards studying at the Universities of Munich and Geneva. Later in his life he was awarded the Ph.D. degree of Berne University. After some years in business as a chemical manufacturer, he retired at a comparatively early age, and devoted his life to the furtherance of trade in this country, particularly in connexion with dyestuffs and other chemicals. Probably his memory will be most honoured for his work for the Manchester Chamber of Commerce; early in his life he was vice-chairman of the chemical section and was largely responsible for the reform of the Patent Laws. In 1910 he became a director of the Chamber, and continued in this office until 1924 when he was elected president for the year 1924–25. During the war he was especially active and was one of the founders of the Association of British Chemical Manufacturers in 1916, afterwards serving for many years on the Council of the Association. In 1916 he became president of the Society of Dyers and Colourists, and will be remembered also as the first chairman of the British Association of Chemists, whilst as a member later of the board of the British Dyestuffs Corporation he did considerable work on behalf of the dyestuffs industry in this country. In the year of his presidency of the Manchester Chamber of Commerce he became the first chairman of the Joint Committee of Cotton Trade Organizations, which succeeded in putting the yarn and cloth trade on a sound basis at a very critical period.

Manchester indeed owes a very great debt of gratitude to Dr. Rée, for in addition to his work for the Chamber of Commerce, chemical industry, and the textile trade, he spent many of his 70 years in the service of the University of Manchester, of which he was treasurer at the time of his death, and was for many years chairman of the chemical section of the College of Technology, serving also for 20 years on the Manchester Education Committee. He has been described as entirely impersonal and unambitious in his work, whilst his capacity for impartial judgment and his great tenacity and industry contributed to make him one of the most popular of this country's industrial leaders.

CORRESPONDENCE

VITAMIN-C AND ASCORBIC ACID

SIR,—In your last issue there appeared, under Proceedings of the Biochemical Society, the abstract of a paper by Birch, Harris, and Ray. In the course of this they mention that "Ostermalt" was found chemically to have a content of hexuronic (ascorbic) acid that should enable it to protect guinea-pigs from scurvy in daily doses of 3·3 g.; no figure was apparently available to the authors enabling them to compare this conclusion with an actual biological assay.

In further substantiation of the authors' views that ascorbic acid and vitamin-C are identical, may I be permitted to state that Ostomalt, to which they presumably refer, as manufactured in these laboratories for the last six years, contains a proportion of concentrated Californian orange juice? The amount of this juice present in Ostomalt is such as to give the equivalent of half its own volume of fresh orange juice to the product. 3·3 g of Ostomalt occupy a volume of about 2·5 ml. and the figures given by Birch, Harris, and Ray for the protective dose of orange juice are 1·2, 1·5, 1·9 ml. It will therefore be seen that the results obtained by their titration method are in good agreement with the equivalent of fresh orange juice present in the product.

A short while ago an independent laboratory, carrying out tests for an official body, found by biological assay that Ostomalt contained an amount of vitamin-C that was "in very fair agreement with their (the manufacturers') claim that the product contained antiscorbutic vitamin equivalent to half its volume of fresh orange juice."

It would therefore seem that the chemical estimation of the vitamin-C present in this product, which is primarily a mixture of malt solids, concentrated orange juice, and cane sugar, with certain other vitamin supplements, is in substantial agreement with direct and indirect biological assays, affording further confirmation for the views of Birch, Harris, and Ray as to the identity of vitamin-C and ascorbic acid.

I am, Sir, etc.,

A. L. BACHARACH,
Chief Chemist,
Glaxo Laboratories.

London, N.W.1
Feb. 27, 1933

PERSONAL AND OTHER ITEMS

The Senate of the University of Dublin has decided to confer the degrees *honoris causa* of Sc.D. on Prof. W. L. Bragg, F.R.S., professor of physics in the University of Manchester, and Prof. J. S. Haldane, F.R.S., director of the Mining Research Laboratory, Birmingham University, and Donnellan lecturer in Dublin University in 1930, and of Litt.D. on Sir Percy Lunn, principal of the London Day Training College.

Prof. J. B. S. Haldane, F.R.S., has been appointed to the Chair of Genetics of London University (University College), the appointment dating from January 1 this year. Prof. Haldane recently resigned the Sir William Dunn Readership in Biochemistry at the University of Cambridge, which he had occupied since 1922. He has also been in charge of the Genetical department at the John Innes Horticultural Institution since 1927, and since 1930 has been Fullerian Professor of Physiology at the Royal Institution.

Prof. Arthur Lapworth, D.Sc., LL.D., F.R.S., has been appointed a Pro-Vice Chancellor of the University of Manchester for a term of two years.

The University Court of Manchester has approved the conferment of the honorary degree of D.Sc. on Dr. J. L. Myers, O.B.E., who has been general secretary of the British Association for the Advancement of Science since 1919, and Fellow and Librarian of New College, Oxford, since 1910.

Sir Gilbert Barling has resigned the office of Pro-Chancellor of the University of Birmingham and will be succeeded by Mr. Walter Barrow.

The directors of Imperial Chemical Industries, Ltd. have appointed as manager of their Silvertown works Mr. J. B. Gandy, who was manager of the Sandbach works until they were dismantled, and later of the Middlewich works.

Mr. R. H. Morgan, consultant chemist, has been awarded the degree of M.Sc. (Wales) following an oral examination and presentation of theses dealing with the scientific treatment of various problems of interest in the foodstuffs industry.

At its meeting in London on February 23 the National Federation of Iron and Steel Manufacturers elected as its president for 1934 Mr. James Henderson, deputy-chairman and general manager of the Frodingham Iron & Steel Co. The following were elected vice-presidents for 1934: Sir John Beale, chairman of British Iron & Steel Co.; Captain R. S. Hilton, managing director of United Steel Companies; Mr. Charles Mitchell, chairman of Dorman Long & Co.; and Mr. Ben Walmsley director of Dorman Long & Co.

Prof. C. M. Thompson, M.A., D.Sc., Emeritus Professor of Chemistry at University College, South Wales, and first chairman of the South Wales Section of the Society who died in January last, left estate of the gross value £27,170, with net personalty £27,099.

Dr. R. Robinson, M.Sc., Ph.D., research assistant a University College, Exeter, has been appointed to th newly-created post of lecturer in physical chemistry a University College, Auckland, New Zealand.

Chemical Industries N.E. Coast Dinner

The North East Coast Annual Dinner of the Chemica and Allied Industries is to be held at the Royal Statio Hotel, Newcastle, on Friday, March 10. This dinne is arranged by the Chemical Society, Institute of Chemis try (N.E. Sections), Society of Chemical Industry (New castle Section), Institute of Metals (N.E. Section North of England Gas Managers' Association, Newcast Chemical Industry Club, and Northern Coke Ove Managers' Association, and on this occasion the speci guests are Dr. H. T. Tizard, F.R.S., and Dr. A. I Dunstan. They have agreed to reply to the toas "The Profession of Chemistry" and "Chemistry an Industry," respectively. The toasts will be proposed b Prof. G. R. Clemo, chairman of the Newcastle Section Society of Chemical Industry, and S. G. Homfray, Es

Dr. J. T. Dunn will occupy the chair. Tickets, price 8s. 6d., may be obtained from Mr. J. W. Craggs, honorary secretary, 4, St. Nicholas Buildings, Newcastle-on-Tyne.

British Standards Institution

The Special Committee appointed to draft a standard Determination of the Agglutinating Value of Coal has completed its first report. Technical criticism by any member of the Society competent to offer it would be welcome.

Copies of the draft specification will be sent in confidence on application to the general secretary of the Society, 46, Finsbury Square, London, E.C.2. The reference 9386 should be quoted.

Chemical Engineering Group

A visit to the Bournville works of Messrs. Cadbury Bros., Ltd. has been arranged on the occasion of the joint meeting of the Chemical Engineering Group and Birmingham Section on March 7. In the evening, at 6 p.m., a paper on "Personnel in Industry" will be given by Mr. W. A. S. Calder, vice-chairman of the Group, in the University Latin Theatre, and this will be followed at 7.45 p.m. by an informal dinner at the Imperial Hotel, Temple Street.

London University New Buildings

At its meeting on February 22 the Senate of the University of London learned with great satisfaction that H.M. the King had intimated his intention of laying the foundation stone of the new University Buildings on Monday, June 26, 1933, and that His Majesty would be accompanied by H.M. the Queen.

Industrial Production in 1932

Figures published in the *Board of Trade Journal* indicate that industrial activity in the United Kingdom was 0·6% smaller in 1932 than in 1931, and 9·8% smaller than in 1930, the index numbers for the three years (1924 = 100) being 93·1, 93·7, and 103·2 respectively. A considerable increase was shown during the year in the output of textile products, whilst the most notable decreases were in the coal output, engineering, and shipbuilding and in the food, drink, and tobacco group. There was a decline of 3·8% in the activity of the non-ferrous metals group, whilst for chemicals and allied trades the index number rose from 95·2 in 1931 to 97·7 in 1932, as compared with 99·3 in 1930.

A New Agricultural Journal

The first number of a new agricultural journal, entitled the *Empire Journal of Experimental Agriculture*, is to be published in April. This journal is intended to offer agricultural research workers a medium for disseminating the records and results of their investigations on the feeding and management of livestock, cultivation and manuring of crops, trials of farm machinery, agricultural economics, and experimental technique. At present the results of many valuable investigations remain unknown, or known only in their country of origin.

The journal will command a strong Editorial board, including among others, Sir John Russell, director of the Rothamsted Experimental Station, as chairman; Sir Rowland Biffen, Sir Daniel Hall, Sir Robert Greig, Sir Frederick Keeble, and leading agricultural authorities in the chief countries of the Empire. Members of this Society will be interested to hear that Dr. E. H. Tripp, who is well known as editor from 1918 to 1922 of the "Review," which was the forerunner of CHEMISTRY AND INDUSTRY, is to be the secretary and general editor of the new journal. The annual subscription is 20s. for four numbers, published quarterly by Mr. Humphrey Milford, Oxford University Press, Warwick Square, London, E.C.4. or single copies will be obtainable for 7s. 6d. net.

New Uses for Bone Glue

An international competition announced this month by the bone glue industry will undoubtedly prove of interest to many chemists. The competition has been organized by the international association known as "Epidos," with the object of promoting interest and research in the development of the uses of bone glues.

It is felt that there may be many outlets for this typical colloid, apart from the well-established uses as an adhesive and sizing agent, and it is hoped, by offering definite prizes, to attract the interest of all chemists still working on colloidal problems.

The competition is not restricted to any one class or section; any individual desiring may compete by the submission of a memorandum drawn up in either English, French, or German.

The memorandum may (1) Indicate the results of research for the purpose of using bone glue in the manufacture of new products, or products in the composition of which, hitherto, bone glue has not entered; or (2) Indicate improvements in processes already using bone glue which will permit of the development of its use.

Provision has been made for prizes to the total value of 20,000 Swiss Francs, which under the rules of the competition *must* be distributed. At least three prizes will be awarded, and no single prize will be less in value than 2,000 Swiss Francs. In addition to the above sum of 20,000 Swiss Francs a supplementary sum of 10,000 Swiss Francs is held in reserve to be employed in certain special circumstances indicated in the rules.

Full information respecting the competition, and also copies of the rules, may be obtained from British Glues & Chemicals, Ltd., Department 1/S, Imperial House, Kingsway, London, W.C.2.

A New Steel

A new steel for structural purposes, with the name "chromadour steel," is being produced by Dorman Long & Co., Ltd., of Middlesbrough. The company began work on the subject in producing a silicon high-tensile steel for the Sydney Harbour Bridge, and in an exhaustive series of experiments now carried out with the new steel, 50% greater strength is said to have been found with also greater resistance to corrosion.

Our Milk Muddle

The last paragraph of the article entitled "Our Milk Muddle," published last week, p. 157, should read: "The call is to chemists—to brush aside all Government authority and medical men, especially Medical Officers of Health, all timorous men—to set to work to find out how our cattle should, can, and shall be fed."

REVIEW

NATURAL VARNISH RESINS. By T. H. Barry. Pp. xii + 294. London: E. Benn, Ltd., 1932. 42s.

The author of this excellently-printed and well-illustrated volume evidently had two objects in view—to rationalize the "industrial chemistry" (if the expression may be used) of the natural resins and to completely supplant the relevant chapters of an earlier book, of which he was part author only. He has succeeded in these objects and if the subject-matter is not arranged in quite the way the reviewer would have arranged it, there is no question about the fact that here is a first-class production, an ambitious venture, especially in the matter of price, and one which will be of interest to the general reader and very helpful to the technologist.

The author is well known as an authority on the natural resins, whilst he has been fortunate in that the last few years have shown considerable development in practically every branch of the subject under discussion. Much new material regarding copals has come from the Dutch in the East Indies, about lac from the Lac Research Institute in India, and from Ruzicka and his colleagues regarding the chemistry and structure of resinous materials. To complete the chain of circumstances the author has been fortunate in his advisers; so much of the information bears the impress of the "man on the spot" that the book is bound to remain for a long time to come as the leading authoritative production on the subject.

Part I deals with the botanical origin, physical properties, the constituents, and chemical examination of resins. It is a pity the short chapter on decomposition of resins by heat is not longer (but the material is not available) because the more there is known about the gum-running process in varnish manufacture the sooner may it be possible to eliminate it; there is no question that the present necessity for gum-running contributes not a little to the economic disabilities under which the natural resins at present lie.

Part II of the book is devoted to the description, origin, and methods of collection of the resins used in the varnish industry. The order in which the various resins are discussed is neither botanical, alphabetical, nor according to any obvious scheme unless it be the author's idea of their relative economic importance. If so, there will be many to disagree. One example of ill arrangement noticed by the reviewer is found on p. 189. Here the chemistry of one type of turpentine, complete with structural formula, is interpolated in a discussion of the geographical distribution of rosin and turpentine.

The chapter devoted to the chemical constitution of rosin and the resin acids gives a good account of current themes mostly based on Ruzicka's work, and indeed is one of the most useful features of the book. The same may be said of the work of Nagel on lac at the Siemens Konzern. The work is well indexed and seemingly provided with all the available statistics. To summarize, natural resins must continue to occupy an important place in the paint and varnish industry, and in this book will be found the data for a true appreciation of their economic value in that industry.

L. A. JORDAN

COMPANY NEWS

BRITISH CYANIDES CO., LTD.

An interim report of the directors of the company states that the profit during the half-year ended December 31, 1932, was 30% greater than that for the year 1931–32, whilst this profit has been arrived at after writing down by £1200 the value of plant at the Birmingham Gas Works, and after writing off expenses incurred on restarting manufacture of prussiate of soda. The address of the company's registered offices will be changed to 1, Argyll Street, London, W.1, from March 1, 1933.

BORAX CONSOLIDATED

At the thirty-fifth ordinary general meeting of the company, whose financial results were given in CHEM. & IND. of February 24, the Rt. Hon. Earl of Leven and Melville, chairman of the company, said that there was little sign of recovery of the company's business in the United States and it had been difficult to carry on business in some European countries owing to restrictions on remittances. With regard to the investment made through the company's American subsidiary in the United States Potash Co., it was stated that the refinery at New Mexico had been completed, and had been producing a high-grade muriate of potash since last September. Both the crude and refined potash salts were giving satisfaction to the contracting fertilizer firms and the value of the enterprise had been fully established. When the Potash Company had completed the payments for the installation of the plant, which would be during the next year, profits should be available for dividend purposes, and a satisfactory return for the investment was expected.

MATHER & PLATT, LTD.

The net profits of this Manchester engineering firm for the year 1932, after provision for depreciation etc., amounted to £106,978, as compared with £76,124 for 1931. With £29,058 brought forward and £27,810 realized by the sale of investments, the available balance is £136,846 after transfer of £27,000 to special reserve. Ordinary dividend is 6%, less tax, as last year, and balance carried forward is £35,027.

STAVELEY COAL & IRON CO.

The directors announce an interim dividend of 2½% tax-free, which is at the same rate as last year.

INDESTRUCTIBLE PAINT CO., LTD.

The net profit of the company for the year 1932 amounted to £34,652, which is practically the same as last year. The turnover was maintained, but selling prices were generally lower, whilst all subsidiaries operated profitably. A final dividend of 10% is announced, again making the total 15%.

COOPER, McDOUGALL & ROBERTSON, LTD.

The profit of this company, manufacturers of sheep-dips, insecticides, etc. was £109,000 for 1932, an increase of £17,655 over the previous year. The divisible balance is £24,748, and the company resumes payment of dividend on the ordinary shares with an allocation of 2½%, after a lapse of one year without dividend. The reserve is again raised by £25,000, whilst the amount carried forward is £51,000.

MARKET REPORT

This Market Report is compiled from special information received from the manufacturers concerned.

Unless otherwise stated, the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acid, Acetic, 40% tech.—£20 5s. per ton d/d address U.K. in casks.

Acid, Chromic.—11d. per lb., less 2½% d/d U.K.

Acid, Hydrochloric.—Spot, 3s. 9d.—6s. per carboy d/d according to purity, strength, and locality.

Acid, Nitric 80° Tw.—Spot, £18—£20 per ton makers' works, according to district and quality.

Acid, Sulphuric.—Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 60s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.

Ammonia (Anhydrous).—Spot, 10d. per lb. d/d in cylinders.

Ammonium Bichromate.—8d. per lb., d/d U.K.

Bisulphite of Lime.—£6 10s. per ton f.o.r. London, packages free.

Bleaching Powder, 35/37%.—Spot, £8 15s. per ton d/d station in casks, special terms for contracts.

Borax Commercial.—Granulated, £15 10s. per ton; Powder, £17 per ton. (For 1-ton lots and upwards, packed in 1-cwt. bags, carriage paid any station in Great Britain.)

Calcium Chloride, Solid, 70/75%.—Spot, £5 5s.—£5 15s. per ton d/d station in drums.

Chrometan.—Crystals, 3¾d. per lb.; Liquor, £19 10s. per ton d/d U.K.

Chromium Oxide.—10d.—10½d. per lb., according to quantity, d/d U.K.

Methylated Spirits, 61 O.P.—Industrial, 1s. 8d.—2s. 3d. per gal.; Pyridinized Industrial, 1s. 10d.—2s. 5d. per gal.; Mineralized, 2s. 9d.—3s. 3d. per gal. 64 O.P. 1d. extra in all cases. Prices according to quantity.

Nickel Sulphate.—£53 per ton d/d.

Nickel Ammon Sulphate.—£53 per ton d/d.

Potash, Caustic.—£30—£33 per ton. Potass. Bichromate crystals and granular.—5d. per lb., net d/d U.K., for spot. Discount according to quantity. Ground, 5¾d. per lb. Potass. Chlorate.—3¾d. per lb. ex whf. Lond. in cwt. kegs.

Potassium Chromate.—6½d. per lb., d/d U.K.

Sal ammoniac, Firsts lump.—Spot, £42 17s. 6d. per ton d/d address in barrels. Chloride of Ammonia.—£37—£45 per ton, carr. paid.

Salt Cake, unground.—Spot, £3 15s. per ton d/d station in bulk.

Soda Ash, 58° E.—Spot, £6 per ton, f.o.r. in bags, special terms for contracts.

Soda, Caustic, solid 76/77° E.—Spot, £14 10s. per ton d/d station in drums, special terms for contracts.

Soda crystals.—Spot, £5—£5 5s. per ton d/d station or ex depôt in 2-cwt. bags.

Sod. Acetate 97/98%.—£21 per ton. Sod. Bicarbonate (refined).—Spot, £10 10s. per ton d/d station in bags. Sod. Bichromate Crystals, Cake, and Powder. —4d. per lb., net d/d U.K., discount according to quantity. Anhydrous 5d. per lb. Sod. Bisulphite Powder 60/62%.—£16 10s. per ton delivered, 1-cwt. iron drums for home trade.

Sodium Chromate.—3¾d. per lb., d/d U.K.

Sod. Phosphate.—£13 per ton, f.o.r. London, casks free. Sod. Silicate 140° Tw.—Spot, £8 5s. per ton d/d station, returnable drums. Sod. Sulphate (Glauber's Salt).—Spot, £4 2s. 6d. per ton d/d. Sod. Sulphide solid, 60/62%.—Spot, £10 15s. per ton, d/d in drums. Crystals, 30/32%.—Spot, £8 per ton, d/d in casks. Sod. Sulphite, Pea Cryst.—Spot, £13 10s. per ton, d/d station in kegs; Commercial.—Spot, £9 10s. per ton, d/d station in bags.

RUBBER CHEMICALS

Antimony Sulphide.—Golden.—6½d.—1s. 1½d. per lb., according to quality. Crimson.—1s. 3d.—1s. 5d. per lb., according to quality.

Arsenic Sulphide, Yellow.—1s. 6d.—1s. 8d. per lb.

Barytes.—£7 10s.—£9 per ton, according to quality.

Cadmium Sulphide.—3s. 1d.—3s. 5d. per lb.

Carbon Bisulphide.—£30—£32 per ton, according to quantity, drums extra.

Carbon Black.—3⅞d.—5¼d. per lb., ex wharf.

Carbon Tetrachloride.—£42—£47 per ton, according to quantity, drums extra.

Chromium Oxide, Green.—1s. 2d. per lb.

Diphenylguanidine.—2s. 4d. per lb.

India-rubber Substitutes, White.—4¼d.—4¾d. per lb. Dark.—3½d.—4¼d. per lb.

Lamp Black.—£46—£50 per ton.

Lead Hyposulphite.—9d. per lb.

Lithopone, 30%.—£18—£19 per ton.

Mineral Rubber "Rupron."—£18 10s. per ton.

Piperidine Rubber Accelerators.—P.P.D.—10s. 6d.—11s. 6d. per lb.; Z.P.D.—7s.—7s. 6d. per lb.; L.P.D.—6s. 6d.—7s. per lb.; P.T.D.—9s. 8d.—10s. 4d. per lb.; C.P.D.—8s. 3d.—8s. 10d. per lb.; S.P.D.—8s. 1d.—8s. 7d. per lb.; P.T.M.—11s. 6d.—12s. 6d. per lb.

Sulphur.—£12 per ton. Sulphur Precip. B.P.—£55—£60 per ton. Sulphur Precip. Comm.—£50—£55 per ton.

Sulphur Chloride.—5d.—7d. per lb., according to quantity.

Vermilion, pale or deep.—4s. 5d.—4s. 9d. per lb.

Zinc Sulphide.—1s. 1d.—1s. 2d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime.—Brown, £8 10s.—£8 15s. per ton. Grey, £10 10s.—£12 per ton. Liquor, Brown, 30° Tw., 6d. per gal.

Acetic Acid, technical, 40%.—£16 10s.—£18 per ton.

Amyl Acetate, technical.—95s.—110s. per cwt.

Charcoal.—£6—£11 per ton, according to grade and locality.

Methyl Acetone, 40/50%.—£50—£52 per ton.

Wood Naphtha.—Miscible.—2s. 7d.—4s. per gal. Solvent, 3s. 9d.—4s. 9d. per gal.

Wood Tar.—£2—£6 per ton.

Wood Creosote.—6d.—2s. per gal.

Acid Carbolic.—Crystals.—9d.—11d. per lb. Crude 60's, 1s. 11d.—2s., 2% water, 2s. 5d. per gal.

TAR PRODUCTS

Acid Carbolic.—Crystals—9d.—11d. per lb. Crude 60's, 1s. 11d.—2s. per gal. 2% water—3s. 0¾d. per gal.

Acid Cresylic, 99/100.—11d.—1s. 8d. per gal. according to specification. Refined, 1s. 8d.—1s. 9d. per gal. Pale, 98%, 1s. 5d.—1s. 7d. per gal. 95%, 11d.—11½d. per gal. Dark, 10d.—1s. 3d. per gal.

Anthracene Oil, Strained, 4½d. per gal.

Benzol.—Prices at works: Crude, 10½d.—11d. per gal.; Standard motor 1s. 6½d.—1s. 7d. per gal.; 90%, 1s. 7d.—1s. 8d. per gal.; Pure, 1s. 10d.—1s. 11d. per gal.

Xylol.—1s. 11d.—2s. per gal. Pure, 2s.—2s. 2d.

Creosote.—Standard specification, for export, 4½d.—5d. net per gal. f.o.b. For home, 3½d.—3¾d. per gal., d/d. Heavy 4d. per gal.

Naphtha.—Solvent 90/160, 1s. 5d.—1s. 6d. per gal. Solvent 95/160, 1s. 7d.—1s. 8d. per gal. Solvent 90/190, 9d.—1s. 2d. per gal.

Naphthalene.—Purified crystals, £9 10s. per ton in bags. *Crude, Hot Pressed, £6 5s. per ton.* Flaked, £11 per ton.

Pitch, medium soft.—95s. per ton, in bulk at makers' works.

Pyridine.—90/140—3s. 9d. per gal.; 90/160—4s.—4s. 6d. per gal.; 90/180—2s.—2s. 3d. per gal.

Toluole.—90%, 1s. 11d.—2s. per gal. Pure 2s. 3d. per gal.

PHARMACEUTICAL AND PHOTOGRAPHIC MATERIALS

Acid, Acetic, Pure 80%.—£39 5s. per ton d/d address U.K. in casks.

Acid, Acetyl Salicylic.—2s. 9d.—2s. 11d. per lb., according to quantity.

Acid, Benzoic, B.P.—1s. 9d.—1s. 11d. per lb. Solely ex Gum, 1s. 3d.—1s. 6d. per oz.; 50-oz. lots, 1s. 3d. per oz.

Acid, Boric, B.P.—Cryst., £35 10s. per ton. Powder, £36 10s. per ton. Ex-Fine Powder, £38 10s. per ton. For 1-ton lots and upwards, packed in 1-cwt. bags, carriage paid any station in Great Britain.

Acid, Camphoric.—19s.—21s. per lb.

Acid, Citric.—9½d. per lb. Less 5%.

Acid, Gallic.—2s. 9d. *per lb. for pure crystal in 1-cwt. lots.*

Acid, Molybdic.—5s. 3d.—5s. 9d. per lb., according to quantity.

Acid, Pyrogallic, Cryst.—6s. 9d. per lb. for 1-cwt. lots. Resublimed, 8s. 6d. per lb. for 28-lb. lots d/d.

Acid, Salicylic.—B.P. pulv., 1s. 7d.—1s. 10d. per lb. *Technical*, 1s. 2d.—1s. 4d. per lb.

Acid, Tannic, B.P.—3s. 9d. per lb.

Acid, Tartaric.—10¾d. per lb. Less 5%.

Acetanilide.—1s. 5d. per lb.

Amidopyrin.—19s. 6d. per lb.

Ammon. Benzoate.—3s. 3d. per lb.

Ammonium Hippurate.—19s. 6d.—23s. 6d. per lb.

Ammonium Iodide.—17s.—17s. 6d. per lb.

Ammonium Molybdate.—5s.—5s. 6d. per lb., according to quantity.

Argent. Nitras, Crystal.—1s. 1d. per oz.

Arsenic Iodide.—22s. 6d.—25s. per lb.

Benzonaphthol.—3s. 3d.—3s. 9d. per lb.

Berberine, Hydrochloride.—5s. 6d.—6s. per oz.; Sulphate, 5s. 6d.—6s. per oz.

Bismuth Salts.—Carbonate, 6s. 10d. per lb.; Citrate, 9s. 3d. per lb.; Nitrate (cryst.), 4s. 7d. per lb.; Oxide, 10s. 6d. per lb.; Salicylate, 7s. 7d. per lb.; Subchloride, 10s. 3d. per lb.; Subgallate, 7s. 3d. per lb.; Subnitrate, 5s. 11d. per lb. Above for cwt. lots. Extra and reduced prices for smaller and larger quantities respectively. *Liquor Bismuthi, P.B.*, in W. Qts.—1s. 1½d. per lb.; 6 W. Qts.—11d. per lb.; 12 W. Qts.—9½d. per lb.; 36 W. Qts.—9d. per lb.

Borax, B.P.—Crystal, £24 10s. per ton. Powder, £25 per ton. For 1-ton lots and upwards, packed in 1-cwt. bags, carr. paid any station in Great Britain.

Bromides, B.P.—Ammonium.—1s. 10d. per lb. Potassium.—1s. 7d. per lb. Sodium.—1s. 9d. per lb. Prices for 1-cwt. lots.

Cadmium Iodide.—17s. 6d.—18s. per lb.

Calcium Hippurate.—26s.—30s. per lb.

Calcium Iodide.—20s. per lb.

Calcium Lactate, B.P.—1s. 2d.—1s. 4d. per lb., according to quantity.

Camphor.—Refined flowers, 3s. 1d.—3s. 2d. per lb. Transparent tablets, 3s. 4d.—3s. 6d. per lb., according to quantity; also special contract prices.

Chloroform.—2s. 3d.—2s. 8d. per lb.

Cocaine, Alkaloid and Citrate.—For export.—29s. 10d.—31s. 7d. per oz. Hydrochloride and Nitrate, 27s. 1d.—28s. 11d. per oz.

Ergosterol.—2s. 6d. per gm.

Ethers.—S.G. 730, 1s. 1d.—1s. 2d. per lb., according to quantity, and other prices according to specific gravity.

Hexamine.—2s. 6d.—2s. 10d. per lb., according to quantity.

Hippuric Acid.—17s. 6d.—21s. 6d. per lb.

Hydrogen Peroxide (12 vols.).—1s. 4d. per gal., f.o.r. *makers' works, naked.* B.P.—*10 vols.*, 2s.—2s. 3d. per gal.; 20 vols., 3s. per gal.

Hypophosphites.—Calcium, 2s. 9d.—3s. 2d. per lb. Potassium.—3s.—3s. 5d. per lb. Sodium, 2s. 11d.—3s. 4d. per lb.

Iodine Resub., B.P.—14s. 8d.—18s. 9d. per lb.

Iodoform, B.P., Cryst., Precip. or Powder.—17s. 7d.—21s. 7d. per lb.

Iron Ammon. Citrate.—B.P.—1s. 10d. per lb. for 28-lb. *lots. Green, 2s. 6d. per lb. (list price).*

Iron Iodide.—17s. 6d.—18s. per lb.

Iron Perchloride.—18s.—20s. per cwt., according to quantity.

Iron Quinine Citrate, B.P.—9½d.—10d. per oz., according to quantity.

Lead Iodide.—14s.—15s. per lb.

Lithium Carbonate, B.P., 1914.—5s. 4d. per lb.

Lithium Chloride, Cryst.—8s. 3d. per lb.

Lithium Citrate.—5s. 3d. per lb. Powder.—5s. 6d. per lb.

Lithium Hippurate.—18s. 6d.—22s. 6d. per lb.

Lithium Iodide.—20s. 6d.—21s. 6d. per lb.

Magnesium Carbonate.—Light, 28s. per cwt.

Magnesium Oxide.—Light, 70s. per cwt.; Heavy, 1s. 8d. per lb.; in quantity lower.

Menthol.—A.B.R., recryst., B.P., 18s. 6d. per lb. net. Synthetic, 8s. 6d.—12s. per lb. Synthetic detached crystals, 8s. 6d.—10s. per lb., according to quantity; Liquid (95%), 8s. 6d. per lb.

Mercurials, B.P.—Red oxide crystals, 5s. 10d.—5s. 11d. per lb.; Levig, 5s. 4d.—5s. 5d. per lb.; Corrosive sublimate, Lump, 4s.—4s. 1d. per lb.; Powder, 3s. 8d.—3s. 9d. per lb.; White precip., Lump, 4s. 9d.—4s. 10d. per lb.; Powder, 4s. 11d.—5s. per lb.; Calomel, 4s. 9d.—4s. 10d. per lb. Yellow Oxide, 5s. 2d.—5s. 3d. per lb.; Persulph., B.P.C., 4s. 11d.—5s. per lb.; Sulph. nig., 4s. 10d.—4s. 11d. per lb. Special prices for larger quantities.

Mercury, Benzoate.—8s. 3d. per lb.; Cyanide, 12s. 7d.—13s. 1d. per lb.; Oleate (5%), 1s. 11d.—2s. 2d. per lb.; (10%), 2s. 9d.—3s. per lb.; (20%), 3s. 9d.—4s. per lb. Protonitras, 6s. 9d. per lb.; Protosulphate, 7s. 3d. per lb.; Subsulphate flav., 7s. 1d. per lb.

Methyl Salicylate.—1s. 4½d.—1s. 6½d. per lb.

Paraformaldehyde.—1s. 3d.—1s. 5d. per lb.
Paraldehyde.—1s. 1d. per lb.
Phenacetin.—4s.—4s. 6d. per lb.
Phenolphthalein.—4s. 5d.—5s. 8d. per lb.
Potass. Bitartrate.—99/100% (Cream of Tartar), 85s. per cwt., less 2½%.
Potass. Citrate.—B.P., 1s. 8d. per lb. for 28-lb. lots.
Potass. Ferricyanide.—1s. 7½d. per lb., in 125-lb. kegs.
Potass. Iodide, B.P.—13s.—15s. 6d. per lb., according to quantity.
Potass. Permanganate.—8¼d. per lb. for 1-ton lots.
Potass. Metabisulphite.—50s. per cwt. d/d London, kegs free.
Potassium Hippurate.—26s.—30s. per lb.
Quinine Sulphate.—2s. 6d. per oz., for 100-oz. tins, tins free.
Saccharin.—37s. 6d. per lb., and lower in quantity.
Salicin.—15s.—16s. per lb., according to quantity.
Santonin.—£50 per kilo for 5-kilo lots.
Seidlitz powder (pulv.).—66s. 3d.—70s. per cwt.
Silver Nitrate.—1s. 3¼d. per oz. for quantity. Sticks, 2d. per oz. extra.
Sod. Barbitonum.—12s. 9d.—14s. per lb.
Sod. Benzoate, B.P.—1s. 7d. per lb., according to quantity.
Sod. Citrate, B.P.C., 1911.—1s. 5d. per lb. B.P.C., 1932, and U.S.P.—1s. 9d. per lb. for 28-lb. lots.
Sodium Hippurate.—23s. 6d.—27s. 6d. per lb.
Sod. Hyposulphite.—Photographic, £15 per ton d/d consignee's station, in 1-cwt. kegs.
Sodium Iodide, B.P.—14s.—17s. 1d. per lb.
Sod. Nitroprusside.—16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt).—75s. per cwt. net for 1-ton lots. Crystals, 2s. 6d. per cwt. extra.
Sod. Salicylate.—Powder, 2s.—2s. 8d. per lb. Crystal, 2s. 1d.—2s. 9d. per lb.
Sod. Sulphide.—Pure recryst., 10d.—1s. 2d. per lb.
Sod. Sulphite anhydrous.—£23—£25 per ton, according to quantity, d/d U.K.
Strontium Iodide.—17s. 6d. per lb.
Tartar Emetic B.P. cryst. or powder.—1s. 9d.—2s. per lb.
Terpine hydrate.—1s. 2d.—1s. 5d. per lb.
Thymol, Puriss.—5s. 9d.—6s. 6d. per lb., *according to* quantity. Natural.—12s. per lb.
Zinc Iodide.—21s.—22s. per lb.
Zinc Stearate.—1s. 4d.—1s. 6d. per lb.

PERFUMERY CHEMICALS

Acetophenone.—7s. per lb.
Aubepine (*ex Anethole*).—8s. 9d. per lb.
Amyl Acetate.—2s. 3d. per lb. Amyl Butyrate.—5s. per lb. Amyl Cinnamic Aldehyde.—8s. 6d. per lb. Amyl Salicylate.—2s. 9d. per lb. Anethol, 21/22° C., 5s. 3d. per lb.
Benzaldehyde free from Chlorine.—3s. per lb.
Benzyl *Acetate from* Chlorine-free Benzyl Alcohol.—1s. 9d. per lb. Benzyl Alcohol free from Chlorine.—1s. 9d. per lb. *Benzyl* Benzoate, 2s. 1d. per lb.
Cinnamic Aldehyde.—Natural, 12s. 6d. per lb.
Citronellol.—8s. 6d. per lb.
Citral.—6s. 6d. per lb.
Coumarin.—14s. 6d. per lb.
Ethyl Cinnamate.—7s. 6d. per lb.
Ethyl Phthalate.—2s. 6d. per lb.
Eugenol.—7s. 6d. per lb. Geraniol (Palmarosa).—17s. 3d. per lb. Geraniol.—6s. 6d.—11s. per lb. Heliotropine.—5s. 9d. per lb. Iso Eugenol.—9s. per lb. Linalol.—(*ex Bois de Rose*) 7s. per lb.—(*ex Shui Oil*) 6s. per lb. Linalyl Acetate.—(*ex Bois de Rose*) 9s. per lb.—(*ex Shui Oil*) 7s. 6d. per lb.
Methyl Anthranilate.—8s. 6d. per lb.
Methyl Benzoate.—4s. 3d. per lb.
Musk Ketone.—30s. per lb.
Musk Xylol.—6s. 6d. per lb.
Nerolin.—4s. per lb.
Phenyl Ethyl Acetate.—10s. per lb.
Phenyl Ethyl Alcohol.—8s. 6d. per lb.
Rhodinol.—60s. per lb. Safrol.—1s. 7d. per lb. Terpeneol.—1s. 6d. per lb. Vanillin (*ex Clove Oil*).—16s.—18s. per lb.—(*ex Guaiacol*)—14s. 3d.—16s. 3d. per lb.

ESSENTIAL OILS

Almond.—Foreign S.P.A., 11s. 6d. per lb. Anise.—2s. 2d. per lb. Bergamote.—8s. per lb. Bourbon Geranium, 24s. 6d per lb.
Camphor.—Brown, 90s. per cwt. White, 90s. per cwt. Cananga, Java, 11s. per lb. Cinnamon Oil.—4s. 3d. per lb. Cassia, 80/85%, 4s. 3d. per lb.
Citronella Oil.—Java, 3s. per lb. Ceylon, 2s. 4d. per lb. Clove.—90/92% English, 4s. 10d. per lb.
Eucalyptus, Australian B.P., 70/75%.—1s. per lb. Lavender.—Mont Blanc, 38/40%.—11s. 3d. per lb. Lemon.—5s. 6d. per lb. Lemongrass.—3s. per lb. Orange, Sweet.—6s. 6d. per lb. Otto of Rose.—Anatolian, 42s. 6d. per oz.; Bulgarian, 62s. 6d. per oz. Palma Rosa, 9s. 6d. per lb.
Peppermint.—Japanese, 6s. 9d. per lb. Wayne County, 14s. per lb. Petitgrain.—6s. 3d. per lb.
Sandalwood, Mysore.—30s. per lb. 90/92%, 19s. 3d. per lb.

INTERMEDIATES

*Items marked thus * d/d buyers' works.*

*Acid, Benzoic, 1914 B.P. *ex Toluol.* 1s. 9½d. per lb. in casks.
*Acid Gamma.—Spot, 4s. per lb., 100%.
*Acid H.—Spot, 2s. 4½d. per lb., 100%.
*Acid Neville and Winther.—Spot, 3s. per lb., 100%.
*Acid Sulphanilic, 8d. per lb.
*Aniline Oil, spot, 8d. per lb., drums extra.
*Aniline Salts, spot, 8d. per lb., casks free.
*Benzaldehyde, spot, 1s. 8d. per lb., packages extra.
*Benzidine Base.—Spot, 2s. 5d. per lb., 100%.
o-Cresol 30/31° C.—£2 6s. 5d. per cwt. in 1-ton lots.
m-Cresol 98/100%.—2s. 3d. per lb., in ton lots.
p-Cresol 34.5° C.—1s. 9d. per lb., in ton lots.
Dichloraniline.—2s. per lb.
*Dimethylaniline.—Spot, 1s. 6d. per lb., packages extra.
Dinitrobenzene.—8½d. per lb.
Dinitrotoluene 48/50° C.—8¾d. per lb. 66/68° C.—9d. per lb.
*Diphenylamine.—Spot, 2s. per lb.
*α-Naphthol.—Spot, 2s. 4d. per lb.
*β-Naphthol.—Spot, £78 15s. per ton, in paper bags; £79 15s. per ton in casks, in 1-ton lots.
*α-Naphthylamine.—Spot, 11½d. per lb.
*β-Naphthylamine.—Spot, 2s. 9d. per lb.
o-Nitraniline.—5s. 10d. per lb.
**m*-Nitraniline.—2s. 7d. per lb.
**p*-Nitraniline.—Spot, 1s. 8d. per lb.
*Nitrobenzene.—Spot, 4½d. per lb., 5-cwt. lots, drums extra.
Nitronaphthalene.—9d. per lb.
*Sodium Naphthionate.—Spot, 1s. 9d. per lb., 100%.
**p*-Toluidine.—Spot, 1s. 11d. per lb.
**o*-Toluidine.—Spot, 9¼d. per lb., drums extra.
m-Xylidine acetate, 3s. 6d. per lb., 100%.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, London, S.W.1, has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and stating the specific number. *Brazil:* Lead, chemical products (310). *British India and Burma:* Chemicals and drugs, disinfectants, lubricating oils (276). *Canada:* Gelatin (279); Paper (280). *Norway:* Paint (299); Paint and varnish (300). *Syria:* Chemical and pharmaceutical products (305).

Merchandise Marks Act, 1926

The Board of Trade announces that, in pursuance of Section 7 of the Merchandise Marks Act, 1926, a draft Order-in-Council was laid before Parliament on February 21, 1933, requiring imported wood wool and wood wool rope to bear an indication of origin on sale or exposure for sale in the United Kingdom. The Draft Order is being published and copies will be obtainable shortly from H.M. Stationery Office, either direct or through any bookseller.

Import Duties Advisory Committee

By the Import Duties (Exemptions) (No. 1) Order, issued on February 22, the Treasury has exempted bismuth metal from customs duty chargeable under the Import Duties Act. The Order, which came into operation on Monday, February 27, gives effect to a report of the Import Duties Advisory Committee, which stated that representations had been made that the continuance of the present duty would necessitate an increase in the price of bismuth salts with a consequent injury to the export trade in this product which is estimated at an annual value of £75,000. There is only a small amount of the metal refined in this country and the Committee did not consider that the continuance of the present duty would lead to any considerable increase. On the other hand they considered that the addition of bismuth metal to the Free List would assist the British export trade in bismuth salts to maintain its position in foreign markets.

I.C.I. Dyestuffs

A further instance of the service which Imperial Chemical Industries, Ltd. is developing for the benefit of the colour using industries is shown by three colour cards (E. 134, B. 171, A. 320) just issued by the company. These illustrate the 1933 Autumn Season Colour Card of the British Colour Council, and examples of the chosen shades are given on silk, cotton, and wool.

Slate for Chemical Plant

A natural slate quarried in the district of Valdres, Norway, and known as "Viking Slate," has on account of its superior quality been used for many years in Norway and England as a roofing slate. Tests made at the Technische Hochschule, Berlin, and more recently at Oslo under the supervision of the Norwegian Geological Survey, show that this slate possesses also a number of features which make it suitable for use in chemical plant. The slate has been shown to be composed mainly of muscovite and quartz, with some ferrous minerals, and an almost complete absence of minerals liable to attack by even the strongest acids. It absorbs practically no liquids and is not affected by temperature changes, *e.g.*, subjection to low temperatures. By reason of these properties, Viking slate has found extensive application for such purposes as the inner lining of electrolytic cells for the manufacture of chlorine. It was first used about 10 years ago in Norway to replace old slate linings in a large plant manufacturing bleached cellulose, and gave such satisfaction that it has since been supplied to many of the leading cellulose factories and chemical plants in Sweden, Finland, Russia, Austria, Germany, France, and even America. It is supplied by Valdres Skifenbrud, Oslo, Norway.

Thomas Broadbent & Sons, Ltd.

In List No. 27 recently issued by Broadbent's, this firm describes the construction and specification of its new direct electrically-driven centrifugals. Features of these which are of interest are the use of a special motor for a.c. power, giving ultra-rapid and smooth acceleration, direct spline-coupling without a clutch, a patent method of mounting the motor which considerably reduces oscillation of the basket during acceleration, and, for d.c. supply, a heavy duty traction-type motor coupled by means of an automatic clutch. The basket can be lined with any class of metal gauze lining, screen, or filter cloth.

PUBLICATIONS RECEIVED

Annual Report of the Institute for Medical Research of the Federated Malay States, 1931. By A. N. Kingsbury. Pp. 126. Kuala Lumpur: Federated Malay States Government Printing Office, 1932.

Introductory College Chemistry: An Elementary Course Developed Historically. By H. G. Deming. Pp. xii + 590. New York: J. Wiley & Sons; London: Chapman & Hall, Ltd., 1933. 18s. 6d.

Calculations of Qualitative Analysis. By C. J. Engelder, Ph.D. Pp. viii + 174. New York: J. Wiley & Sons; London: Chapman & Hall, Ltd., 1933. 12s. 6d.

Rezept-Taschenbuch für die Lackindustrie. By H. Hadert. Pp. 482. Berlin: O. Elsner, Verlagsges., 1933. 40 rm.

Report of the Fuel Research Board for the Year ended March, 1932. With Report of the Director of Fuel Research. Department of Scientific and Industrial Research. Pp. viii + 96. London: H.M. Stationery Office, 1933. 2s.

Low-Temperature Carbonisation: Narrow Brick Retorts at the Fuel Research Station. By J. Fraser Shaw. Department of Scientific and Industrial Research. Fuel Research. Technical Paper No. 35. Pp. vi + 14. London: H.M. Stationery Office, 1933. 6d.

Eléments de Pharmacodynamie Spéciale. Étude de l'Action des Divers Médicaments. By E. Zunz. Vol. I. Pp. vii + 496. Vol. II. Pp. 497—1271. Paris: Masson et Cie, 1932. 190 fr.

Les Colloïdes: Leurs Gelées et Leurs Solutions. By P. Bary. 2nd ed. Pp. xii + 586. Paris: Dunod, 1933.

Unsere Lebensmittel und ihre Veränderungen. By Dr. W. Ziegelmayer. Pp. xv + 324. Dresden and Leipzig: T. Steinkopff, 1933. Paper, 10 rm.; bound, 11.20.